

## 15.

**Eastern Pacific Expeditions of the New York  
Zoological Society. XXV.**

**Fishes from the Tropical Eastern Pacific.  
[From Cedros Island, Lower California, South to the Galápagos  
Islands and Northern Peru.]**

**Part 2. Sharks.<sup>1</sup>**

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&

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(Plates I & II; Text-figures 1-34).

[This is the twenty-fifth of a series of papers dealing with the collections of the Eastern Pacific Expeditions of the New York Zoological Society made under the direction of Dr. William Beebe. The present paper is concerned with specimens taken on the *Noma* Expedition (1923), the *Arcturus* Oceanographic Expedition (1925), the *Antares* Expedition (1933), the Templeton Crocker Expedition (1936) and the Eastern Pacific *Zaca* Expedition (1937-1938). For data on localities, dates, dredges, nets, etc., of the second, fourth and fifth of these expeditions, refer to *Zoologica*, Vol. 8, No. 1, pp. 1-45 (*Arcturus*); *Zoologica*, Vol. 22, No. 2, pp. 33-46 (Templeton Crocker), and *Zoologica*, Vol. 23, No. 14, pp. 278-298 (Eastern Pacific *Zaca*).]

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<sup>1</sup> Contribution No. 622, Department of Tropical Research, New York Zoological Society.

<sup>2</sup> The general arrangement adopted here is that of E. Grace White (*Bull. Amer. Mus. Nat. Hist.*, 74 (2), 1937: 36-38).

Superfamily Squaloidea	
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### INTRODUCTION.

This paper deals with sharks collected in tropical eastern Pacific waters on five expeditions of the Department of Tropical Research of the New York Zoological Society under the direction of Dr. William Beebe. As an aid to future students we have included all species that have been recorded from the eastern tropical Pacific.

The geographical boundaries of the region under consideration in this paper and which we call the "tropical eastern Pacific" are as follows: The coastal waters of North and South America from Cedros Island off the west coast of Lower California, and the Gulf of California, southward to northern Peru, including off-shore islands such as the Galápagos and Revillagigedo groups, and Clipperton, Cocos and Malpelo Islands.

As far as references are concerned, we have listed the original reference with the type locality, and references referring to the region under discussion. Additional references have been added, however, whenever their inclusion was felt necessary. Some of the more commonly cited papers have been referred to by name and not by publication, serial and page numbers; the full references will be found on page 122. Synonyms of nominal forms described from the region are included, but not necessarily those from extralimital localities.

Thirty-three sharks are reported from the waters of the tropical eastern Pacific as delimited. As might be expected, most of these species are forms that live dominantly in warm waters. But surprisingly enough a number of species usually found widely distributed in warm waters of other parts of the world and that might be expected to be in our region, are unreported from the area under consideration. Whether this absence is an actual one, or whether it is the result of comparatively few collections having been made in the region, is a question. Under any circumstances these sharks must be uncommon as there have been a sufficient number of collections made in the region to have produced at least one specimen of these species.

We are indebted to Dr. Leonard P. Schultz of the U. S. National Museum, Mr. John T. Nichols of the American Museum of Natural History, Prof. Albert E. Parr of the Peabody Museum, Yale University, and Dr. H. B. Bigelow and Mr. William C. Schroeder of the Museum of Comparative Zoology, Cambridge, for the loan of material and for valuable information; to Miss Janet Wilson for inking the outline drawings and

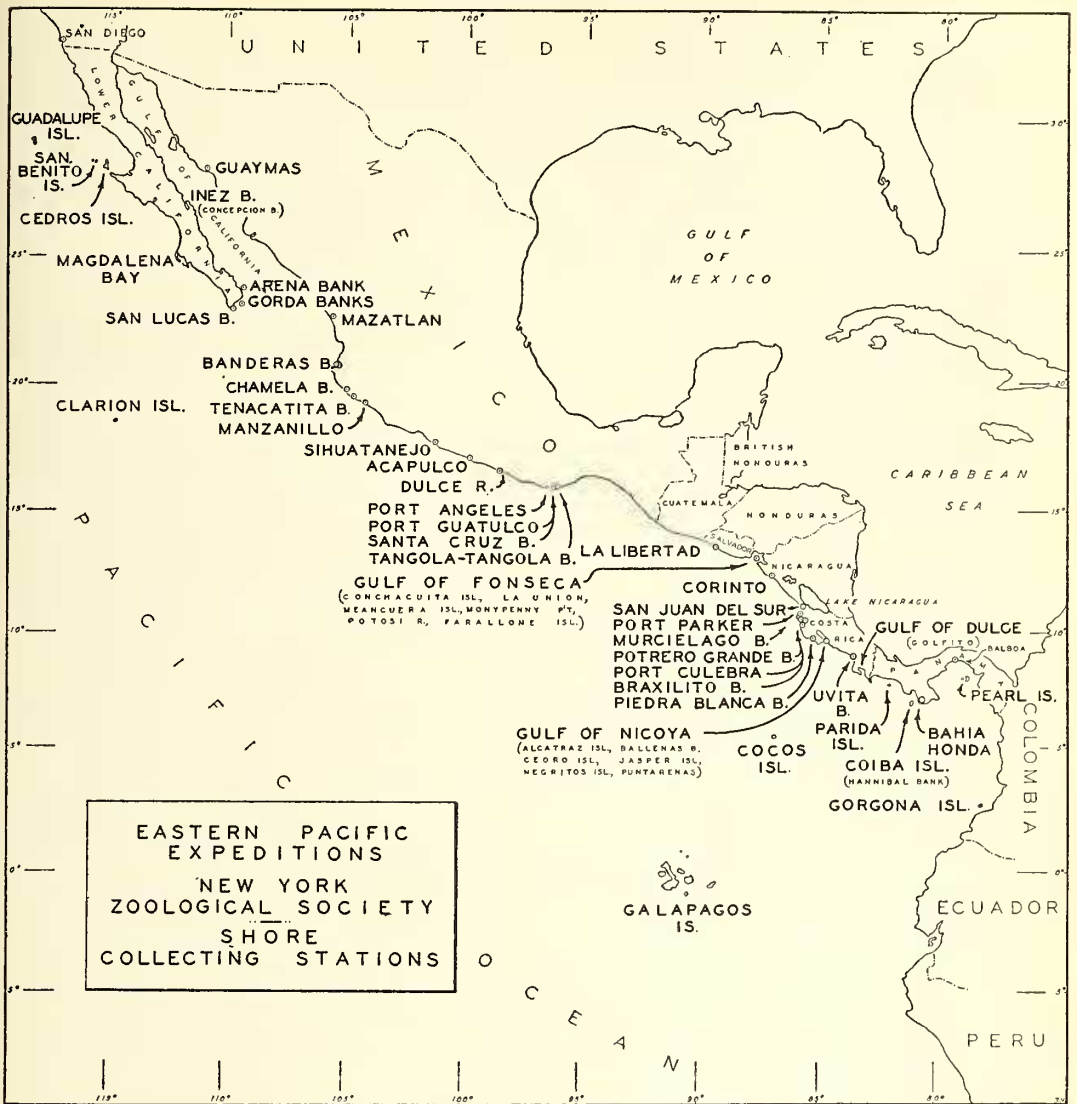
to Miss Jocelyn Crane and Mr. Toshio Asaeda for photographs.

### Key to the Families of Sharks of the Tropical Eastern Pacific<sup>3</sup>

1. Body not markedly depressed or expanded laterally, except in the case of the hammer-head sharks, where the head only is expanded 2  
Body depressed, usually widely expanded laterally.....16
2. Gill-openings 6 or 7 on each side, a single dorsal fin.....3  
Gill-openings 5 on each side, two dorsal fins.. 4
3. Body greatly elongate, almost eel-shaped; mouth anterior....*Chlamydoselachidae*, p. 96  
Body moderately elongate; mouth inferior  
*Hexanchidae*, p. 96
4. Anal fin present.....5  
Anal fin absent.....15
5. Dorsal fins provided with a strong spine anteriorly.....*Heterodontidae*, p. 117  
Dorsal fins without spines anteriorly.....6
6. First dorsal fin over or behind the pelvic fins.. 7  
First dorsal fin in advance of the pelvic fins.. 8
7. Nostrils confluent with the mouth; tail directed upward somewhat from the body  
*Orectolobidae*, p. 96  
Nostrils not confluent with the mouth; tail not directed upward from the body  
*Scylliorhinidae*, p. 99
8. Caudal peduncle with a keel on each side; caudal fin lunate.....13  
Caudal peduncle without a keel on each side; caudal fin not lunate, its upper lobe two or more times the length of the lower.....9
9. Tail exceedingly long, forming about one-half of the total length; eyes without nictitating membranes or folds.....*Alopiidae*, p. 97  
Tail moderately developed, forming less than one-third the total length; eyes with nictitating membranes or folds.....10
10. Head hammer- or kidney-shaped, its sides extended laterally.....*Sphyrnidae*, p. 114  
Head normally formed, without lateral extensions.....11
11. More than two rows of teeth in use; teeth in bands or pavement.....12  
One or two rows of teeth in use; teeth compressed, triangular, not in bands or pavement  
*Galeorhinidae*, p. 104
12. Teeth pavement-like, the cusps flattened  
*Mustelidae*, p. 102  
Teeth not pavement-like, each tooth with three to five sharp cusps.....*Triakidae*, p. 100
13. Last gill-opening entirely in front of the pectoral fins.....14  
Last gill-opening above the base of the pectoral fins; size enormous.....*Rhineodontidae*, p. 97
14. Gill-openings very large, extending from the back and nearly meeting under the throat; teeth very small; size enormous  
*Cetorhinidae*, p. 98  
Gill-openings moderate, not as above; teeth very large and sharp.....*Isuridae*, p. 98

<sup>3</sup>In addition to the families found in the eastern tropical Pacific, a few other families have been included that have representatives immediately north and south of the province here treated. These have been inserted on the presumption that they might be found sometime within the area.

The keys in this paper are based only upon the species that are found within the area under consideration; they will not necessarily be found to apply to sharks of the same genera in other parts of the world.



Text-figure 1.

Principal localities in the tropical eastern Pacific where collections were made by the Department of Tropical Research of the New York Zoological Society.

- 15. Dorsal fins each provided with a spine  
*Squalidae*, p. 120
- Dorsal fins without spines *Scymnorhinidae*, p. 121
- 16. Gill-openings on sides of body; anterior extension of the pectoral fins separated from the

neck by a deep notch in which lie the gill-openings.....*Squatinae*, p. 121

Gill-openings on under side of the body. (Rays and mantas; these will be treated in a succeeding paper.)



## Systematic Account.

### Family CHLAMYDOSELACHIDAE.

#### *Chlamydoselachus* Garman, 1884.

##### *Chlamydoselachus anguineus* Garman.

Unrecorded from our region, although Garman<sup>4</sup> mentions the following: "This shark is one that may confidently be expected to appear in future collections from the region about the Galápagos."

### Family HEXANCHIDAE.

#### *Hexanchus* Rafinesque, 1810.

*Hexanchus griseus*, the six-gilled shark, is one of a number of sharks unrecorded from the tropical eastern Pacific, but reported from immediately north and south of the region under consideration. On the Pacific coast the range is from San Diego, California, northward, and the species is known from Chile, if the synonymizing of the South American form with the northern is correct.

#### *Heptranchias* Rafinesque, 1810.

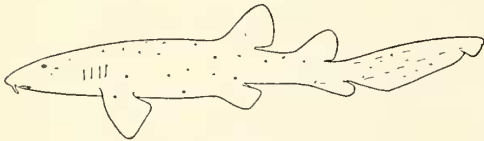
The seven-gilled sharks also have representatives both north and south of the region from Cedros Island to northern Peru.

### Family ORECTOLOBIDAE.

#### *Ginglymostoma* Muller & Henle, 1837.

##### *Ginglymostoma cirratum* (Gmelin).

Nurse Shark (Sand Shark; Gato).



Text-figure 2.

**Range:** In our province from the Gulf of California, south to Ecuador. (Mexico: Gulf of California, Mazatlan, Jalisco, Chamela Bay, Manzanillo; Costa Rica: Port Parker, Potrero Grande, Gulf of Nicoya; Panama: Bahia Honda, Panama Bay; Ecuador: St. Helene Bay.)

**Field Characters:** A sluggish, blunt-headed shark with very small eyes; mouth transverse and near the tip of the snout, furnished with a pair of barbels; two large dorsal fins placed far back, the first over the pelvis; the fourth and fifth gill-slits very close together. Olive brown; young covered with small black spots which usually disappear in the adult. (Illustration after Garman; 365 mm.)

No detailed comparison has been made at first hand between nurse sharks from the Atlantic and from the Pacific, and though probably there is specific differentiation, we can consider them at present as only a single species.

**Size:** Reaches a length of 10 feet.

**Local Distribution:** Feeding and usually living close to the bottom in shallow water near shore.

**Abundance:** Cannot be considered a rare shark wherever it is found.

**Food:** A 385 mm. shark taken from a tide pool in Costa Rica had eaten two carideans and five small fishes. One of the latter was a *Rupiscartes allanticus* (85 mm.) and another an *Anchoviella* (43 mm.). An adult shark had eaten a six-inch fish.

**Enemies:** Man was the only enemy of this shark which came to our notice. A dozen nurse sharks, six to eight feet in length, were found on the beach at a camp devoted to drying shark fins, near the tip of Lower California, on May 1, 1936. Unlike the other three species found at this camp, the nurse sharks had their fins intact, these having evidently no commercial value.

**Parasites:** Two leeches, *Pontobdella muricata*, were taken from a nurse shark.

**Breeding:** The largest specimen (2,800 mm.) showed no signs of active breeding; the smallest (295 mm.) was taken in a tide pool at Bahia Honda, Panama, on March 19, 1938.

**Study Material:** We observed this shark seven times; three specimens were collected, the others were watched through helmet or water-glass. Mexico: Chamela Bay, 1, observed, ca. six feet, Nov. 10, 1937; Manzanillo Bay, 1 (26,093) 392 mm., Jan. 10, 1938, poisoned; Costa Rica: Port Parker, 1, ca. four feet, Jan. 13, 1938, observed; Potrero Grande, 1, ca. seven feet, Jan. 23, 1938, observed in 2 feet of water; Gulf of Nicoya, (26,170) 2,880 mm., Feb. 23, 1938, snagged through dorsal with hook from *Zaca*; Panama: Bahia Honda, 1, (26,206) 295 mm., March 19, 1938, poisoned in tidepool; Bahia Honda, 1, ca. 300 mm., March 19, 1938, specimen lost, from same pool as 26,206.

**References:** *Squalus cirratus*, Bonnaterre, Tabl. encyc. meth., Ichthy., 1788: 7 (original description).

*Ginglymostoma cirratum*, Jordan, D. S. & Gilbert, C. H., *Bull. U. S. Fish Comm.*, 2, 1882: 105 (Mazatlan, Mexico). Jordan, D. S. & Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 5, 1883: 371 (First record from Pacific coast, 2 ten-inch specimens collected by Xantus, Colima, Mexico). Jordan, D. S. & Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 5, 1883: 620 (Panama). Vaillant, L. L., *Bull. Soc. Philom., Paris*, (8) 6, 1894: (Gulf of California). Jordan, D. S., *Fishes of Sinaloa*, 1895: 381, (color, common name "Gata," 3 specimens, 2 to 6 feet). Jordan, D. S. & Evermann, B. W., *Fishes North and Middle America*, 1, 1896: 26 (short description). Boulenger, G. A., *Bull. Mus. Torino*, 13, 1898: 1 (Ecuador). Gilbert, C. H. & Starks, E. C., *Fishes Panama*

<sup>4</sup> Garman, S., *Mem. Mus. Comp. Zool.*, 24, 1899: 41.



Bay, 1904: 5 (color, Panama). Garman, S., *Bull. Mus. Comp. Zool.*, 46, 1906: 229 (Panama). Regan, C. T., *Proc. Zool. Soc. London*, 1908: 350 (synonymy, description, Jalisco, Mexico). Garman, S., *The Plagiostomia*, 1913: 54, plate 7 (description, figures). Meek, S. E., & Hildebrand, S. F., *Marine Fishes of Panama*, 1, 1923: 29 (Panama, description).

*Ginglymostoma fulvum*, Jordan, D. S., *Proc. U. S. Nat. Mus.*, 8, 1886: 363 (listed as a doubtful species).

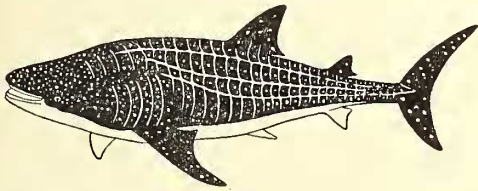
#### Family RHINEODONTIDAE.

*Rhincodon* Smith, 1849. (Usually considered as a misprint for *Rhineodon*.)

##### *Rhineodon typus* Smith.

Whale Shark.

(Plate 1, Figs. 1 & 2).



Text-figure 3.

**Range:** Warm waters of the Atlantic, Pacific and Indian Oceans. In the eastern tropical Pacific it is known from the following localities, Mexico: Gulf of California, Cape San Lucas, Acapulco; Panama: Panama Bay, Galápagos Islands; Peru: Callao.

**Field Characters:** A giant whale-like shark with spotted head and with the body covered with longitudinal and transverse pale bands forming a checker-board; each space in the checker-board with a pale yellowish spot. (Illustration after Norman, 1937.)

**Size:** Grows to 45 feet long, with possible records ranging up to 70 feet.

**General Habits:** Considering its size, this is a common fish in Gulf of California waters. Our observations on the species are summarized in "Zaca Venture," pages 162-170.

**Study Materials:** No specimens. Many observations and photographs were made of this species in the Gulf of California.

**References:** *Rhincodon typus*, Smith, A., *Zool. Journal*, London, 16, 1829: 443-444 (original description; type locality, Table Bay, Cape of Good Hope, South Africa).

*Micristodus punctatus*, Gill, T. N., *Proc. Acad. Nat. Sci., Phila.*, 17, 1829: 177. Gill, T. N., *Science*, 15, 1902: 824-826. Jordan, D. S. & Evermann, B. W., *Fishes North and Middle America*, 1, 1896: 52 (Quotes original description of teeth). Mowbray, L. L., Preliminary Report on the Taking of the Pacific Whale Shark during

the Scientific Cruise of the Yacht "Nourmahal" in the North Pacific, 1933, under the direction of Vincent Astor, Privately printed, July, 1933, No. 1, 2 pp. (Galápagos Islands).

*Rhineodon typicus*, Smith, R. W., *Illustrations Zool. South Africa*, 1849: Plate 26. Nation, W. S., "South Pacific Times," Callao, Peru, Jan. 24, 1878. (Callao, Peru). Chierchia, G., *Collezioni per Studi di Scienze Naturali Fatte nel Viaggio Intorno al Mondo della R. Corvetta "Vettor Pisani"* . . . . . Anni 1882-83-84-85. Roma, 1885: 66-68 (Panama Bay). Grey, Z., *Santa Catalina Islander*, May 27, 1925: 10 (Cape San Lucas). Grey, Z., "Fishing Virgin Seas," New York, 1925: 204-216 (Cape San Lucas). Beebe, W., "The Arcturus Adventure," New York, 1926: 414 (Galápagos Islands). Gudger, E. W., *Science*, 65, 1927: 545 (Galápagos Islands). Gudger, E. W., *Science*, 65, 1927: 211-212 (Gulf of California). Gudger, E. W., *Nature*, 132, 1933: 569 (Galápagos Islands). Lonnberg, E., *Fauna och Flora Upsala*, 1933: 97-104 (Acapulco, Mexico). Gudger, E. W., *Proc. Zool. Soc. London*, 1934: 874-878 (Distribution in the eastern tropical Pacific). Gudger, E. W., *Natural History*, 36, 1935: 128-132 (Acapulco, Mexico). Gudger, E. W. & Smith, R. S., *Bull. N. Y. Zool. Soc.*, 68-71 (six specimens at Acapulco, Mexico, photographs). Beebe, W., *Bull. N. Y. Zool. Soc.*, 39, 1936: 241-242 (notes, photographs), (Gulf of California, Cape San Lucas). Gudger, E. W., *Nature*, 141, 1938: 516 (Panama). Gudger, E. W., *California Fish and Game*, 24, 1938: 420-421 (Lower California). Fowler, H. W., *Acad. Nat. Sci. Phila.*, Monograph 2, 1928: 248 (Galápagos Islands, check-list). Beebe, W., "Zaca Venture," New York, 1938: 162-170 (observations and harpooning, abundance, size, Gulf of California and Cape San Lucas).

#### Family ALOPIIDAE.

##### *Alopias* Rafinesque, 1810.

##### *Alopias vulpinus* (Bonnaterre).

The thresher-shark, although supposedly world-wide in distribution, is unrecorded from our area, but it has been found in considerable numbers in southern California and in Chile. Walford, in writing of southern California *Alopias vulpinus*, states: "It has been recorded on our coasts as far north as Coos Bay, Oregon, and is said to extend at least as far south as the Isthmus of Panama." This statement seems to be the only recorded reference to the species in coastal tropical eastern Pacific waters.

*Alopecias barrae* Philippi<sup>5</sup> and *A. longimana* Philippi,<sup>6</sup> both reported from Chile, are considered by Fowler<sup>7</sup> as being the same as *Alopias vulpinus*.

<sup>5</sup> Philippi, R. A., *Anales Univers. Chile*, 71, 1887: 553, pl. 5, fig. 2.

<sup>6</sup> Philippi, R. A., *Anales Univers. Chile*, 109, 1901: 308.

<sup>7</sup> Fowler, H. W., *Proc. 4th Pac. Sci. Congr., Java* 1929, *Biol. Pap.* 3, 1930: 488.

Whitley<sup>8</sup> points out that the assumption that *Alopias vulpinus* has a world-wide distribution may not be correct. A number of new forms of *Alopias* have been described, and the eastern tropical Pacific form may very well represent another species.

### Family ISURIDAE.

Key to genera mentioned in this paper.

- 1a. Teeth slender and sharp, with entire edges.  
 1b. Teeth compressed and triangular, with serrated edges. . . . . *Isurus*  
 . . . . . *Carcharodon*

### *Isurus* Rafinesque, 1810.

- 1a. Teeth with a basal cusp on each side. . . . . *nasus*  
 1b. Teeth without basal cusps, long, flexible and acute. . . . . *glaucaus*

*Isurus nasus* (Bonnaterre) and *Isurus glaucaus* (Müller & Henle).

The genus *Isurus* and the species mentioned above are unreported from our province, although they are present north and south of the area if the Chilean *Lamna hudsoni*<sup>9</sup> is the same as *Isurus glaucaus* as Fowler states,<sup>10</sup> and if *Lamna philippi* Perez<sup>11</sup> is the same as *Isurus nasus*, as Fowler mentions in the same publication.

We have the jaws of an *Isurus* obtained from a native in the Gulf of Dulce, Costa Rica. There is no definite locality record for this jaw, and although it was probably taken from somewhere within our region, we have no positive assurance that this was so.

This specimen would be referred to *glaucaus* in the key. There are 13 teeth on each side in each jaw, the teeth becoming progressively smaller from front to back. The teeth are smooth and there is no indication of cusps. The longest teeth measure 31 mm. from base to tip. In the upper jaw the third tooth is considerably smaller than the following teeth, being approximately equal in size to the eighth. The space between the third and fourth teeth in the upper jaw is wider than the spaces between other teeth.

### *Carcharodon* Müller & Henle, 1838.

#### *Carcharodon carcharias* (Linnaeus).

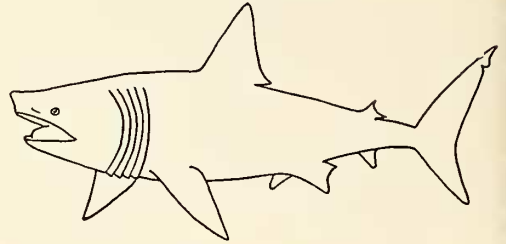
There seems to be no authentic record of the great white shark in our region, although from the distribution of the species one would expect to find it. It is recorded from southern California and from Chile.

### Family CETORHINIDAE.

### *Cetorhinus* Blainville, 1816.

#### *Cetorhinus maximus* (Gunner).

Basking Shark.



Text-figure 4.

*Range:* Arctic, Antarctic and temperate seas; in the eastern tropical Pacific it is known from Ecuador and Peru and from somewhere near the Galápagos Islands. On the northern limit of the area under discussion it is known from southern California, and there is a questioned record from near Cape San Lucas.

*Field Characters:* A very large shark with long gill-slits extending from the back and almost meeting under the throat. Caudal fin lunate, with keels on each side near the base. Back leaden gray, lower sides white. Often found drifting at the surface. (Illustration after Norman, 1937.)

*Size:* Grows to 45 feet.

*Study Material:* None.

*References:* *Squalus maximus*, Gunner, J. E., *Trondjhem selskr.*, 3, 1765: 33, tab. 5 (original description, coast of Norway).

*Cetorhinus*, Stevenson, C. H., *Rep't. U. S. Fish Comm.* 28, 1902 (1904): 227-228 (Peru and Ecuador, use for oil). Gudger, E. W., *Science*, 42, 1915: 653-656 (Occurrence in the southern hemisphere).

Basking shark, Grey, Z., "Tales of Fishing in Virgin Seas," New York, 1925: 185 (Questionable sight record, Cape San Lucas. "I saw the dark leathery fin of a basking shark stick up out of the water. It was immense. But before we could get near enough for a picture it sank").

*Cetorhinus maximus*, Gudger, E. W., *Science*, 65, 1927: 545 (locality "not far from the Galápagos"). Fowler, H. W., *Proc. 4th Pac. Sci. Congr.*, Java 1929 (1930): 489 (range; includes California, Ecuador, Peru). Gudger, *Proc. Zool. Soc. London*, 1934 (1935): 877 (Contains the following statement ". . . and not *Cetorhinus*, which latter shark is, however, found all along the western coast of South America, and even in the vicinity of the Galápagos Archipelago.")

*Discussion:* As Norman suggests (*Discovery Reports*, 16, 1937: 7) the southern basking shark, as represented by Falkland Island and southern

<sup>8</sup> Whitley, G. P., *Rec. Austr. Mus.*, 20 (1), 1937: 5.

<sup>9</sup> Philippi, R. A., *Anales Univers. Chile*, 71, 1887: 551.

<sup>10</sup> Fowler, H. W., *Proc. 4th Pac. Sci. Congr.*, Java 1929, *Biol. Pap.* 3, 1930: 488.

<sup>11</sup> Perez, C. C., see Philippi, R. A., *Anales Univers. Chile*, 71, 1887: 549.



South American specimens, may prove to be distinct from the northern species. The specimens from Peru, Ecuador and the Galápagos Islands may represent a northward projection of the range of this southern race or species of basking shark.

The record of basking shark near Cape San Lucas, made by Zane Grey in "Tales of Fishing in Virgin Seas," page 185, must be questioned until further records of this shark are secured in Gulf of California waters. The record was merely the sight of a dorsal fin which disappeared before Grey could approach near enough to secure a photograph.

### Family SCYLLIORHINIDAE.<sup>12</sup>

Key to genera and species of the tropical eastern Pacific.<sup>13</sup>

- 1a. Labial folds absent or rudimentary; belly capable of inflation. (Color grayish-brown, tinged with yellowish above and below; back with black cross-bars; upper parts with large round black spots. . . . . *Cephaloscyllium uter*)
- 1b. Labial folds present; belly not inflatable.
  - 2a. First dorsal fin originating behind the origin of the pelvics; base of the second dorsal fin shorter and wholly above that of the anal fin, the latter overlapping it before and behind; belly pale. . . . . *Pristiurus xaniurus*
  - 2b. First dorsal fin originating well in front of the pelvics; second dorsal fin about equal to the anal in size, and terminating slightly behind it; belly same color as rest of the body. . . . . *Cephalurus cephalus*

<sup>12</sup> The genera in this family are not easy to differentiate and it is possible that many of them ought to be merged or at least recognized as subgenera. We have here followed Garman, 1913, except for the use of *Scylliorhinus* in place of *Catulus*.

*Halaelurus chilensis* (Guichenot) of Chilean and southern South American waters, approaches the borders of the region under consideration. It has been recorded from Mollendo, Peru, by Evermann, B. W. & Radcliffe. L. (*Bull. U. S. Nat. Mus.*, 95, 1917: 3).

<sup>13</sup> *Apristurus brunneus* (Gilbert). The range of this species has been noted as including the Gulf of California. However, this is not true and the species is known, as far as the literature is concerned, only from north of the United States boundary. The history of the false Gulf of California record seems to be as follows:

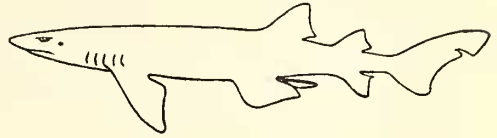
In the original description of *Catulus brunneus* (*Proc. U. S. Nat. Mus.*, 14, 1891 (1892): 542), which is included in a paper entitled "Descriptions of thirty-four new species of fishes collected in 1888 and 1889, principally among the Santa Barbara Islands and the Gulf of California," no mention is made of the type locality of the species. Jordan & Evermann, in "Fishes of North and Middle America," Vol. 1, page 24, supplied the deficiency by stating "Gulf of California," and this notation has been copied in a number of papers. Unfortunately, this selection of a type locality is not in accord with the known distribution of *brunneus* and, in addition, a checking of the type, No. 51,708, U. S. National Museum, reveals that it was taken at Albatross station No. 2396, 32° 49' N. Lat., 117° 28' 30" W. Long., in 359 fathoms, on February 4, 1889. This locality is about 10 miles west of Point La Jolla, California, quite within the generally known range of the species, and a long distance from the Gulf of California.

*Apristurus brunneus* may thus be removed from consideration as a Gulf of California species, and the type locality should be changed in the literature to coincide with the notes given above.

### *Cephaloscyllium* Gill, 1861.

#### *Cephaloscyllium uter* (Jordan & Gilbert).

Swell Shark.



Text-figure 5.

*Range:* Monterey Bay to northern Lower California, with a single record at Acapulco, Mexico.

*Field Characters:* Small, blunt-headed sharks with first dorsal fin far back on the body, over the pectoral fins; teeth small, tricuspid, in about four series. Grayish-brown with bands and spots of black, sometimes with white spots on the body. Belly capable of great inflation. (Illustration after Jordan & Evermann, 1900: 790 mm.).

*Size:* Grows to about three feet.

*Study Material:* None.

*References:* *Catulus uter*, Jordan, D. S., & Gilbert, C. H., in Jordan, D. S., & Evermann, B. W., "Fishes of North and Middle America," 1, 1896: 25 (new name and description, questions relationship to Chilean *ventriosum*).

*Scylliorhinus ventriosus*, Garman, S., *Mem. Mus. Comp. Zool.*, 24, 1899: 26 (" . . . *S. ventriosus* Garman, from Acapulco and northward . . .").

*Discussion:* All of the records of this species with the exception of one are from the region from Monterey, California, to Ensenada, Mexico. The exception is the record of Garman, listing the species from Acapulco, Mexico.

Garman, in the Acapulco record, synonymized the northern form *uter*, with the Chilean *ventriosus* which he had described in 1880. The similarity and dissimilarity of the northern and southern forms had been recognized by Jordan & Gilbert when the name *uter* was given to the California specimens. Considering the lack of records from the warm waters south of Acapulco, we retain the California form as a species distinct from the South American one.

### *Pristiurus* Müller & Henle, 1838.

#### *Pristiurus xaniurus* (Gilbert).

File-tail Shark.



Text-figure 6.



Range: Coast of southern and Lower California, south to San Roque Bay, in 184 to 684 fathoms.

Field Characters: Small sharks with two dorsal fins placed far back on the body, the first dorsal above the ventrals; anal fin present; upper edge of caudal in adult with a broad band of enlarged scales; labial fold of lower jaw slightly shorter than the fold of the upper jaw. Dark slaty brown, usually uniform above, sometimes with small whitish spots, the fins often edged with paler; belly pale. (Illustration after Garman, 1913: 552 mm.)

Size: Grows to about two feet.

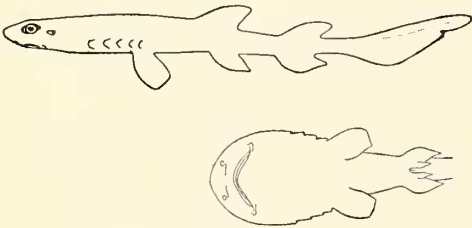
Study Material: None.

References: *Catulus xaniurus*, Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 14, 1891 (1892): 540 (original description, abundance; type locality, Southern and Lower California, in 184 to 684 fathoms). Gilbert, C. H., *Rep't. U. S. Fish Comm.*, 1893 (1895): 461 (off Central California in 200 to 456 fathoms; spines and spinelets, young, claspers). Jordan, D. S. & Evermann, B. W., *Fishes of North and Middle America*, 1, 1896: 24 (description). Townsend, C. H., & Nichols, J. T., *Bull. Amer. Mus. Nat. Hist.*, 52, 1925: 5 (18 specimens from 27° 07' N., 114° 33' W., off San Roque Bay, Pacific coast of Lower California, in 284 fathoms).

*Parmaturus xaniurus*, Walford, L. A., *Div. Fish and Game California, Fish Bull.*, 45, 1935: 27 (short description, distribution, figure). Garman, S., *The Plagiostomia*, 1913: 90, Plate 9, figs. 1-5 (description, figure).

**Cephalurus** Bigelow & Schroeder, 1941.

*Cephalurus cephalus* (Gilbert).



Text-figure 7.

Range: Gulf of California; 85 to 100 miles N. W. of Cape San Lucas, Lower California, and near Clarion Island, in 85 to 460 fathoms.

Field Characters: Very small, rather broad-headed sharks with wide crescentic mouth; second dorsal fin about equal to anal in size, with its posterior base termination behind that of the anal; brown, the belly same color as the rest of the body. (Illustration after Bigelow & Schroeder, 1941.)

Size: Grows to about 10 inches.

Study Material: 1 specimen. Mexico, off the south-western Coast of California, No. 12,831, *Amer. Mus. Nat. Hist.*, length 206 mm.

References: *Catulus cephalus*, Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 14, 1891 (1892): 541 (original description, Gulf of California at 362 fathoms, and near Clarion Island at 460 fathoms). Garman, S., *The Plagiostomia*, 1913: 78 (short description; comment on inadequacy of the original description; placed provisionally in *Catulus*). Townsend, C. H., & Nichols, J. T., *Bull. Amer. Mus. Nat. Hist.*, 52, 1925: 6 (specimens from 85 to 100 miles northwest of Cape San Lucas, in 389 to 405 fathoms).

Family TRIAKIDAE.

Key to tropical eastern Pacific genera.

- 1a. Spiracles present; no caudal pit. . . . . *Triakis*
- 1b. Spiracles absent; caudal pit present. *Triadenodon*

**Triakis** Müller & Henle, 1838.

Key to tropical eastern Pacific species.<sup>14</sup>

- 1a. Grayish with cross bands and large alternating spots of brown; median cusp of teeth acuminate, lateral cusps short. . . . . *semifasciata*
- 1b. Slaty brown, with scattered small spots of black; median cusps of teeth short, broad-based, lateral cusps short. . . . . *maculatus*

*Triakis semifasciatum* Girard.



Text-figure 8.

Range: Cape Mendocino, California, to Magdalena Bay, Lower California. (Mexico: Cedros Island, Port San Bartholomae, Turtle Bay, Ballenas Bay and Magdalena Bay.)

Field Characters: An easily recognizable shark: gray with well-defined cross bands of black on the upper parts, interspaced with round black dots along the sides.

Size: Grows to about 3 feet in males, females over five feet.

Study Material: We have no material. At Clarion Island in the Revillagigedo group, a specimen supposedly of this species was caught and lost on a feather-fly. The shark was about four feet long.

References: *Triakis semifasciatum*, Girard, C. F., *Proc. Acad. Nat. Sci. Phila.*, 7, 1854: 196 (original description; type locality, Presidio de San Francisco). Lockington, W. N., *Proc. Acad. Nat. Sci. Phila.*, 1881 (1882): (Magdalena Bay). Fowler, H. W., *Proc. Acad. Nat. Sci. Phila.*, 60, 1908: 59 (Use of *felis* in place of *semifasciatum*). Osburn, R. C., & Nichols, J. T., *Bull. Amer.*

<sup>14</sup> From Garman, S, 1913: 165.

*Mus. Nat. Hist.*, 35, 1916: 141 (3 specimens in seines, Cedros Island, Port San Bartholome and Ballenas Bay, Lower California). Wales, J. H., *Copeia*, 1932: 163 (Ensenada and Turtle Bay, Lower California; many seined at latter locality). Walford, L. A., *Div. Fish and Game California, Fish Bull.*, 45, 1935: 32 (Short description, range, etc., figure). Barnhart, P. S., *Mar. Fishes South. California*, 1936; 9, fig. 14 (short description and color; figure).

***Triakis maculata* Kner & Steindachner.**

*Range:* Recorded by Fowler from California, Mexico, Peru and Chile.

*Field Characters:* Small sharks; slaty brown with numerous irregular scattered spots of black on the back and flanks. Teeth small, numerous, more than two rows functioning, each tooth with the central cusp short, broad at base and directed obliquely outward; the lateral denticles of each tooth are mere rudiments separated from the principal cusp by a shallow notch.

*Size:* Grows to about two feet.

*Study Material:* None.

*References:* *Triakis maculatus*, Kner, R., & Steindachner, F., *Sitzb. Akad. Wiss. Wien*, 54, 1867: 391 (original description, "Sudsee," Listed as "*Triakis scyllium* Dum., vel *maculata*, n. sp.). Steindachner, F., *Sitz. Akad. Wiss. Wien*, 60, 1870: 315 (Mazatlan, Mexico). Garman, S., *The Plagiostomia*, 1913: 167 (Redescription of the species from Callao, Peru, specimens). Fowler, H. W., *Proc. 4th Pac. Sci. Congr.*, Java 1929, *Biol. Pap.* 3; 1930: 490 (Lists following range: California, Mexico, Peru and Chile).

*Discussion:* This species was described by Kner & Steindachner from a specimen taken from the indefinite locality "Sudsee." However, the other species of fish listed in the same paper are from Chile and Peru, so that it is not unlikely that the types came from the west coast of South America. In 1870 Steindachner listed a specimen from Mazatlan, Mexico, and in 1913 Garman redescribed the species from specimens taken at Callao, Peru. Fowler in 1930 listed the range as we have recorded it. We have been unable to find the Californian and Chilean references upon which the range is based.

***Triaenodon* Müller & Henle, 1837.**

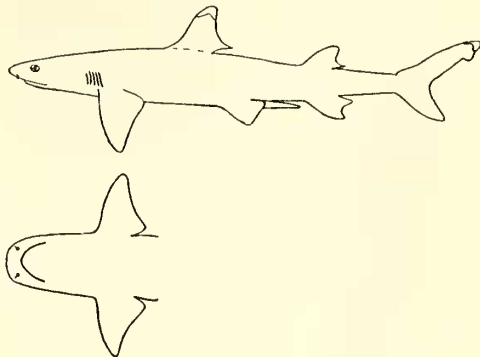
***Triaenodon obesus* (Ruppell).**

(Plate II, Fig. 1).

*Range:* Red Sea, Indian Ocean, Oceania including Hawaii, Cocos Island and Panama. (In the eastern tropical Pacific three specimens are known, two from Cocos Island and one from Bahia Honda, Panama. The Panama specimen here recorded is the first reported occurrence of the species on the American continent.)

*Field Characters:* A blunt-headed shark with mouth close to and paralleling the outer border

of the head; nostrils with a conspicuous triangular flap; nictitating membrane present; first dorsal fin nearer ventrals than pectorals; teeth with a long median cusp and with a smaller cusp, rarely two, at the base on each side; tips of the dorsal fins and the upper caudal lobe white. (Illustration after Fowler, 1928: 645 mm.)



Text-figure 9.

*Description:* The single specimen secured by us agrees with current descriptions.<sup>15</sup> For comparative purposes we append the following account of this 1,175 mm. (46¼ inches) fish. Proportions are stated in percentages of the length to the tip of the last caudal vertebrae (1,125 mm.).

Head broad, depressed, the upper surface quite flat; snout broadly rounded, the mouth close to and paralleling the outer border of the head but slightly nearer the sides of the head laterally than anteriorly; preoral length 3.6%, width of mouth 8.5; symphysis of lower jaw to line joining the angles of the jaw 4.7; mouth strongly arched with a small crease on the upper lip on each side and with a deep pit at the gape on each side in the lower jaw. Nostrils to snout 3.7; internarial space 4.6; nostrils with a large conspicuous triangular flap on their inner halves. Eye a broad horizontal oval with a large nictitating membrane, diameter 1.85; distance from snout to eye 6.9; distance from eye to mouth 2.7. Snout to first gill-opening 18, snout to fifth gill-opening 22; height of first gill-opening 2.65, height of fifth gill-opening 3.1; last gill-slit over the base of the pectoral fin. Snout to first dorsal fin 38, the fin rather sharp superiorly and with a sharp-pointed posterior lobe; first dorsal fin much closer to pelvis than to the pectorals; base of first dorsal 8.9, anterior edge 12.2, vertical height of fin from body 9.2, base to tip of lower lobe 4.4. Interdorsal space 17.8. Snout to

<sup>15</sup> The eastern Pacific records of the genus (Cocos Island, Hawaii) have been considered up to the present, as referable to *obesus*. Whitley, however (*Australian Zoologist*, 9 (3) 1939: 237), suggests that the Hawaiian form as represented by Fowler's Laysan Island example which the latter called *obesus*, is an "ally" of *obesus*.

As mentioned above our specimen agrees so closely with the current descriptions of *obesus* that we see no reason for using another name.



second dorsal fin 64; base of second dorsal 6.1, anterior edge 8.5, vertical height 6, base to tip of lower lobe 3.8, origin of fin very slightly ahead of the anal. Anal fin from snout 65.5, base 5, anterior edge 9.1, base to tip of posterior lobe 3.55. Base of second dorsal to upper caudal pit 8.35; base of anal to inferior caudal pit 8.35. Upper caudal pit to tip of caudal 24.8; inferior caudal pit to tip of lower caudal lobe 12.7; tip of caudal to notch of terminal lobe 6.75. Base of pectoral from snout 24.6, the fin large and low, its tip somewhat pointed, anterior edge of fin 14.6, inner edge 5, base of pectoral 5. Pelvic fins from snout 50, the fin truncate posteriorly, base of fin 6.1, anterior edge 7.3, inner edge of fin from the inner posterior tip to the separation of the fins anteriorly 6.5.

Teeth in both jaws tricuspid (rarely with five cusps), the median cusps much larger than the lateral ones, in about 45 rows in each jaw (the rear teeth difficult to count as the jaws were not dissected and the teeth extend far back into the mouth), those in the upper jaw erect anteriorly, becoming oblique and backwardly inclined on the sides posteriorly. Denticles from the upper side beneath the first dorsal fin are 5 to 7 keeled, the outer keels when 7 are present, very small, the denticles closely packed together.

*Color:* In life dark gray above, shading into dead white below, the tips of the second dorsal fin and the upper lobe of the caudal fin dead white. Irregularly scattered dark spots on the sides and tail, all smaller than the eye. Iris pale green with faint blackish angular lines.

Snodgrass & Heller state the color of their Cocos Island fish as follows: "dark uniform slate above, below livid yellowish slate; tip of 1st dorsal and of upper lobe of the caudal creamy white." Herre gives the color of his specimen from the same locality preserved in alcohol as: "more or less brownish or rusty brown above, paler to whitish beneath; the tips of the dorsals and upper caudal lobe are milky white, the margins of the other fins dark or blackish."

*Size:* Grows to at least 5 feet in our region.

*Local Distribution:* Our single specimen was speared close inshore at night.

*Abundance:* An uncommon species, represented by three records in the eastern Pacific American waters.

*Food:* The stomach of our fish contained a 205 mm. snapper-like fish.

*Study Material:* 1 specimen. Panama: Bahia Honda, 1, female (26186) 1,175 mm., Mar. 15, 1938, speared.

*References:* *Carcharias obesus* Ruppell, W. P. E. S., Neue Wirbelthiere zu der Fauna von Abyssinien gehörig, 1835: 64, Pl. 18, fig. 2 (original description, figure; type locality, Red Sea).

*Triænodon obesus*, Snodgrass, R. E., & Heller, E., *Proc. Wash. Acad. Sci.*, 6, 1905: 344 (range, description, color; Cocos Island); Fowler, H. W., *Proc. Ath. Pac. Sci. Congr.*, Java, 1929, 3 (1930):

489 (Check list, range); Herre, A. W., *Field Mus. Nat. Hist., Zool. Ser.*, 21, 1936: 24 (short description, color, range; Cocos Island); Fowler, H. W., *Acad. Nat. Sci. Phila., Monograph* 2, 1938: 249 (check-list, Cocos Island).

*Discussion:* Whitley has recently pointed out that the genus *Triænodon* was mentioned earlier than the usually accepted first reference of Müller & Henle (*Syst. Besch. der Plagiostomen*, 1838-1841: 55). The references referred to are as follows: Müller & Henle, *Ber. Verh. kon. Preuss. Akad. Wiss. Berlin*, 2, 1837: 113, and *Mag. Nat. Hist.* (ed. Charlesworth) 2, 1838: 38.

In the last two references cited above there is no mention of a genotype. In the first reference, two species are recognized under *Triænodon*, *obesus* and *smithii*. As Müller & Henle state (footnote p. 56, of last-mentioned reference), that *smithii* belonged to the genus *Leptocarias*, it is obvious that *obesus* must be the genotype.

In our specimen of *Triænodon obesus*, the nictitating membrane is complete and not a fold, as is indicated in White's "Key to Galea" (*Bull. Amer. Mus. Nat. Hist.*, 74, 1937: 121) in alternative (55).

#### Family MUSTELIDÆ.

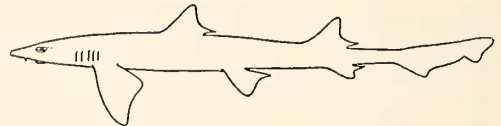
#### *Mustelus* Linck, 1790.<sup>16</sup>

Key to species of the tropical eastern Pacific.

- 1a. Lower lobe of the caudal fin pointed, arcuate.  
*lunulatus*
- 1b. Lower lobe of caudal fin rounded.
  - 2a. Midpoint of base of first dorsal fin much closer to origin of ventral fins than to axil of the pectorals. . . . . *californicus*
  - 2b. Midpoint of base of first dorsal fin as close to axil of pectoral fins as to the ventrals or closer. . . . . *dorsalis*

#### *Mustelus californicus* Gill.

Gray Smooth Hound.



Text-figure 10.

*Range:* Cape Mendocino, California, southward into the Gulf of California (Mexico: "Lower California," Magdalena Bay, Cape San Lucas, Rio Colorado, Guaymas).

*Field Characters:* Small sharks with teeth in flattened pavement-like rows; preoral length about equal to or a little less than the width of the mouth; lower lobe of caudal fin ending obtuse-

<sup>16</sup> We have made no attempt to consider the species of the genus recorded from Peru and southward. Some of these may belong to other genera; they are *mento* (*edulis*), *abbotti* and *nigromaculatus*. See Bigelow & Schroeder, *Proc. Boston Soc. Nat. Hist.*, 41 (8) 1940: 417-438), for data on these forms.



ly; center of base of first dorsal fin nearer root of ventrals than pectorals. Dark lead gray, white below. (Illustration from specimen No. 443, Mus. Comp. Zool.; 615 mm.).

*Size:* Grows to about 3½ feet.

*Study Material:* 3 specimens. Mexico: Cape San Lucas, 3 (24815, 24821, 24822) female and two embryos about to be born, March 30, 1936, hand line (only embryos saved).

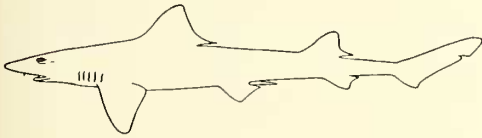
*References:* *Mustelus californicus*, Gill, T. N., *Proc. Acad. Nat. Sci. Phila.*, 16, 1864: 148 (original description, type locality, San Francisco, California). Lockington, W. N., *Proc. Acad. Nat. Sci. Phila.*, 1881: 114 (Lower California). Starks, E. C., *Copeia*, 46, 1917: 61-63 (comparison with *M. henlei* and *M. lunulatus*; Mexico: Ensenada and Magdalena Bay). Springer, S., *Proc. U. S. Nat. Mus.*, 86, 1939: 468 (in key to genus).

*Galeorhinus californicus*, Breder, C. M., Jr., *Bull. Bingham Oceano. Coll.*, 2 (1), 1926: 3 (Rio Colorado, Lower California).

*Galeus dorsalis*, Evermann, B. W., & Jenkins, O. P., *Proc. U. S. Nat. Mus.*, 14, 1891: 129 (Guaymas, Mexico; embryo; see Gilbert & Starks, Fishes of Panama Bay, p. 7).

### *Mustelus dorsalis* Gill.

Tollo.



Text-figure 11.

*Range:* Gulf of California, southward to Colombia and ? Peru. (Mexico: Gulf of California; Costa Rica: Uvita Bay; Panama: Panama; Peru: Callao.)

*Field Characters:* Small sharks with teeth in flattened, pavement-like rows; preoral length about equal to width of mouth; first dorsal fin with center of its base equidistant from base of pectoral and ventral fins; lower lobe of caudal fin not prominent, ending obtusely; uniform grayish above, whitish below, no conspicuous color markings. (Illustration from specimen No. 26,176: 488 mm.)

*Size:* Grows to about three feet.

*Study Material:* 1 specimen. Costa Rica: Uvita Bay, male (26176) 480 mm., March 2, 1938, taken on hand line.

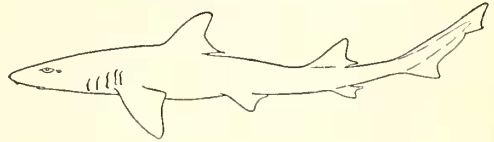
*References:* *Mustelus dorsalis*, Gill, T. N., *Proc. Acad. Nat. Sci. Phila.*, 1864: 149 (original description; Panama, type No. 8068, U. S. Nat. Mus.). Günther, A., *Trans. Zool. Soc. London*, 6 (7), 1868: 396 (check list), 490 (copied description). Günther, A., *Cat. Fishes Brit. Mus.*, 8, 1870: 388 (note). Jordan, D. S. & Gilbert, C. H.,

*Bull. U. S. Fish Comm.*, 2, 1882: 109 (name only, Panama). Jordan, D. S., & Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 5, 1882 (1883): 109 (Key differentiating this species from *lunulatus* and *canis*). Jordan, D. S., & Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 5, 1882 (1883): 373 (List of Dow's specimens, type from Panama). Pellegrin, J., *Bull. Mus. Hist. Nat., Paris*, 7, 1901: 161 (Gulf of California). ? Evermann, B. W., & Radcliffe, L., *U. S. Nat. Mus., Bull.* 95, 1917: 7, plate 1, fig. 3, plate 2, fig. 1 (measurements, description, figures). Nichols, J. T. & Murphy, R. C., *Bull. Amer. Mus. Nat. Hist.*, 46, 1922: 504 (Callao, Peru). Springer, S., *Proc. U. S. Nat. Mus.*, 86, 1939: 467 (in key).

*Galeus dorsalis*, Jordan, D. S., *Proc. U. S. Nat. Mus.*, 8, 1885 (1886): 363 (check-list, Panama). Jordan, D. S., & Bollman, C. H., *Proc. U. S. Nat. Mus.*, 12, 1889 (1890): 179 (name only). Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 13, 1890 (1891): 449 (Panama). Jordan, D. S., & Evermann, B. W., *Fishes North and Middle America*, 1, 1896: 30 (description, range, color). Gilbert, C. H., & Starks, E. C., *Fishes of Panama Bay*, 1904: 7, Plate 1, fig. 2 (comments on description, measurements, figure of head). Osburn, R. C. & Nichols, J. T., *Bull. Amer. Mus. Nat. Hist.*, 35, 1916: 141 (Tiburón Island, Gulf of California; three-foot female with six unborn ten-inch young).

*Galeorhinus dorsalis*, Garman, S., *The Plagiostomia*, 1913: 178 (synonymy, description, color). Meek, S. E. & Hildebrand, S. F., *Marine Fishes of Panama*, 1, 1923: 32 (short synonymy, note on embryos, description; Panama market).

### *Mustelus lunulatus* Jordan & Gilbert.



Text-figure 12.

*Range:* Southern California to Colombia. (Mexico: Santa Inez Bay, Concepcion Bay, Guaymas, Mazatlan; Costa Rica: Port Parker; Panama: Panama Bay; Colombia: Gorgona Island.)

*Field Characters:* Small sharks with teeth in flattened pavement-like rows; preoral length greater than width of mouth; center of base of first dorsal closer to base of pectoral fins than to pelvis; lower lobe of caudal fin prominent, ending in a point. Uniform grayish above, pale below. (Illustration after Kumada & Hiyama, 1937: 472 mm.)

*Size:* Grows to 5 feet 8 inches.

*Study Materials:* 6 specimens. Mexico: Santa Inez Bay, Lower California, 2, April 13, 1936 (not saved); Santa Inez Bay, 1, 4 feet long; April 23, 1936 (not saved); Concepcion Bay, 1 (24994), April 13, 1936. Costa Rica: Port

Parker, 1 (26114), 700 mm., Jan. 16, 1938, captured on hook, teeth saved; Colombia: Gorgona Island, 1 (26211), 890 mm., March 27, 1938.

References: *Mustelus lunulatus*, Jordan, D. S. & Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 5, 1882: 108 (original description; type locality: Mazatlan, Mexico; type No. 29211, U. S. Nat. Mus.). Jordan, D. S. & Gilbert, C. H., *Bull. U. S. Fish Comm.*, 2, 1882 (1883): 105 (check-list, Mazatlan, Mexico). Jordan, D. S. & Evermann, B. W., *Fishes North and Middle America*, 1, 1896: 28 (description). Jordan, D. S. & Evermann, B. W., *Fishes North and Middle America*, 3, 1898: 2745 (in key to west coast *Mustelus* and *Galeus*). Jordan, D. S. & McGregor, R. C., *Rep. Comm. Fish.* for 1898 (1899): 274 (Ensenada, Lower California, short description). Gilbert, C. H. & Starks, E. C., *Fishes of Panama Bay*, 1904: 5, Plate 1, fig. 1 (comparison with northern specimens, proportions, measurements, etc., figure), 207 (check-list, range). Starks, E. C., *Copeia*, 46, 1917: 63 (comparison with *Mustelus henlei* and *Mustelus californicus*). Norris, H. W., *Copeia*, 114, 1923: 1 (California, size, abundance, young). Kumada, T. & Hiyama, Y., *Marine Fishes Pacific Coast of Mexico*, 1937: 16, Plate 47 (Mexico; figure). Springer, S., *Proc. U. S. Nat. Mus.*, 86, 1939: 464 (comparison with *norrisi*, etc.), 467 (in key to *Mustelus*).

*Galeus lunulatus*, Jordan, D. S., *Proc. U. S. Nat. Mus.*, 8, 1885 (1886): 363 (check-list; name only). Evermann, B. W. & Jenkins, O. P., *Proc. U. S. Nat. Mus.*, 14, 1891 (1892): 128 (Guaymas, Mexico). Jordan, D. S., *Fishes of Sinaloa*, 1895: 382 (Mazatlan, abundance).

*Galeorhinus lunulatus*, Garman, S., *The Plagiostomia*, 1913: 174 (description, color, range). Meek, S. E. & Hildebrand, S. F., *Marine Fishes of Panama*, 1, 1923: 33 (short synonymy, description, comparison with *dorsalis*; range; Panama).

*Cynias lunulatus*, Starks, E. C. & Morris, E. L., *Univ. Cal. Publ. Zool.*, 3 (11), 1907: 163, 164 (comparison with *M. californicus*).

Family GALEORHINIDAE.

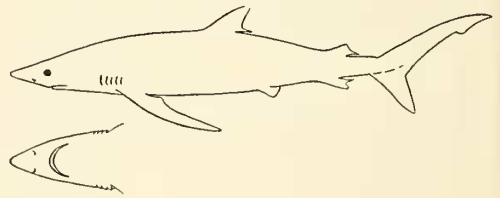
Key to genera of the tropical eastern Pacific.

- 1a. Spiracles absent.
  - 2a. Lower labial folds wanting or rudimentary.
    - 3a. First dorsal fin inserted posteriorly, the mid-point of its base nearer ventral than pectoral fins. . . . . *Prionace*
    - 3b. First dorsal fin inserted anteriorly, the mid-point of its base nearer pectoral than ventral fins.
      - 4a. Second dorsal fin almost as large in area as the first; teeth of both jaws smooth, narrowly triangular, with wide basal shoulders, the shoulders extending on each side of the central triangular portion. . . . . *Aprionodon*
      - 4b. Second dorsal fin very much smaller than the first dorsal; teeth of at least the upper jaw serrated, more or less triangular. . . . . *Eulamia*

- 2b. Labial folds well developed, present on both jaws; teeth not serrate. . . . . *Scoliodon*
- 1b. Spiracles present, small, situated behind the eye.
  - 5a. Teeth large, alike in both jaws, deeply notched on the outer edge and convex on the inner, heavily serrated; body in small and medium sized fish usually with irregular dark spots on the sides which often coalesce to form bars; these spots and bars tend to disappear with age. . . . *Galeocerdo*
  - 5b. Teeth not deeply notched, curved on both sides; color and pattern not as above  
*Galeorhinus*

*Prionace* Cantor, 1849.

*Prionace glauca* (Linnaeus).



Text-figure 13.

Range: Tropical seas throughout the world; on the Pacific coast of America from Puget Sound southward to the Gulf of California; on the southern border of the tropical eastern Pacific it is recorded from Chile. (Mexico: Carmen Island, Gulf of California.)

Field Characters: Large, elongate sharks with short head and long tapering snout; first dorsal fin closer to pelvic fins than to pectorals; upper teeth triangular, convex externally, concave internally, all strongly serrated. Color above rich deep blue. (Illustration after Garman, 1913.)

Size: Grows to 15 to 20 feet.

Study Material: None.

References: *Galeus glaucus*, Linnaeus, *Systema Naturae*, 10th Ed., 1, 1758: 235 (original description).

*Prionace glauca*, Osburn, R. C., & Nichols, J. T., *Bull. Amer. Mus. Nat. Hist.*, 35, 1916: 141 (young specimen, hand-line, Carmen Island, Gulf of California).

Discussion: With the exception of the one Gulf of California specimen, records of this species are conspicuous by their absence in our region. The species is recorded north and south of the tropical eastern Pacific, both along the United States coast and in Chile.

Fowler has synonymized the Chilean *Carcharias pugae* Perez, *C. gracilis* Philippi and *C. aethiops* Philippi with this species. In addition to these Chilean records there are a number of others under the name of *glaucus*.

Whitley<sup>17</sup> uses the name *Carcharhinus* in place of *Prionace* for the blue sharks. The former

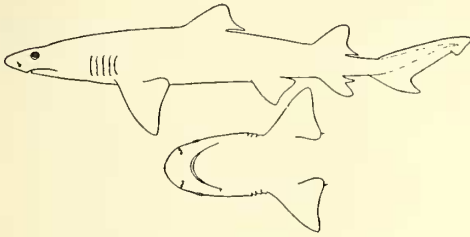
<sup>17</sup> Whitley, *Fishes of Australia*, Part 1, The Sharks, 1940: 107.



name has been hurled about to such a degree that we prefer retaining *Prionace* for the present for this genus.

*Aprionodon* Gill, 1861.

*Aprionodon fronto* (Jordan & Gilbert).



Text-figure 14.

*Range:* Mexico, Costa Rica. (Mexico: Guaymas, Mazatlan; Costa Rica: Port Parker. Our Port Parker specimen extends the range of this species some 1,500 miles southeastward along the coast.)

*Field Characters:* A shark with the second dorsal fin almost as large as the first, its base  $\frac{4}{5}$ th as long as that of the first, the fin larger than the anal and originating slightly further forward; pectoral fin broad, its breadth 70% of the length of the fin; teeth of both jaws narrowly triangular with wide basal shoulders, edges of teeth smooth. (Illustration from Specimen No. 26,116: 704 mm.)

*Description:* The proportions, expressed in percentages of the total length, of the specimen obtained by the *Zaca*, are as follows: Specimen No. 22,116, 704 mm. total length. Length to caudal notch 76%; snout to origin of first dorsal fin 36.2; snout to origin of second dorsal fin 63; snout to origin of pelvic fins 50.5; snout to origin of anal fin 64.2; vertical of posterior pectoral base to origin of first dorsal fin 6.95; vertical of inner tip of pectoral fin to origin of first dorsal fin 2.8; First dorsal fin base 9.5, anterior edge 11.2, posterior edge 4.25, vertical height from body 6.4. Interdorsal space 19.2. Second dorsal fin base 6.95, anterior edge 8.7, posterior edge 3.7, vertical height of fin from body 6. Caudal fin length 22.5, tip to origin of terminal lobe 5.7, length lower lobe 11.2. Pectoral fin base 6.1, anterior edge 14.8, posterior edge 6.5, greatest breadth 10.7. Pelvic fin base 6.25, anterior edge 7.6, posterior edge 3.62. Anal fin base 5.35, anterior edge 7.7, posterior edge 3.05, vertical height from body 5. Snout to eye 7.95, eye diameter 1.8. Snout to mouth 5.26, mouth width 9.2, symphysis to line joining angles of the mouth 5.1. Snout to outer angle of nostrils 4.83, internarial space 5.55, nostril to mouth 2.7, length of nostril 1.63. Snout to 1st gill-slit 19.5, snout to 5th gill-slit 23.3. Height of 1st gill-slit 4.1, height of 5th gill-slit 4.1.

Teeth of both jaws narrowly triangular with

broad, shoulder-like basal portion and with no trace of serrations. Laterally the teeth tilt backwards, increasingly so posteriorly. The teeth farthest back, because of this tilting, have the posterior basal portion accentuated. The edges of the teeth are translucent and rather delicate and a ragged broken edge can be produced by the slightest effort.

*Color:* In life the upper surfaces are in general yellow-green; two broad dark bands begin at the nape and unite in back of the second dorsal fin. Below pale green, becoming almost white on the lower snout, chin and between the pectoral fins.

*Size:* The three known specimens of this species are small, 704, 723 and 915 mm. (27 to 36 inches).

*Food:* Our specimen contained the remains of an unidentifiable fish about 115 mm. long.

*Local Distribution:* Seined close inshore in daylight over a sandy beach.

*Study Material:* 1 specimen. Costa Rica: Port Parker, 1 female (26,116) 704 mm., Jan. 18, 1938, seined.

*References:* *Carcharias fronto*, Jordan, D. S. & Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 5, 1882: 102-103, not large specimen mentioned on page 104 (description; type-locality: Mazatlan, Mexico; type No. 28167, U. S. Nat. Mus.). Jordan, D. S. & Gilbert, C. H., *Bull. U. S. Fish Comm.*, 2, 1882: 105 (Mazatlan, Mexico; common name).

*Eulamia fronto*, Evermann, B. W., & Jenkins, O. P., *Proc. U. S. Nat. Mus.*, 14, 1891 (1892): 129 (Guaymas, Mexico; 28 inch specimen).

*Carcharinus fronto*, ? Jordan, D. S., *Fishes of Sinaloa*, 1895: 382 (erroneous note referring to a large, man-eating shark). Jordan, D. S. & Evermann, B. W., *Fishes North and Middle America*, 1, 1896: 39 (description; length erroneously given as 10 feet). Jordan, D. S., *Proc. U. S. Nat. Mus.*, 8, 1885 (1886): 363 (check-list).

*Carcharinus milberti*, Garman, S., *The Plagiostomia*, 1913: 133 (synonymy only, in part).

*Carcharinus milberti*, Meek, S. E. & Hildebrand, S. F., *Marine Fishes of Panama*, 1, 1923: 38 (synonymy only, in part).

? *Eulamia plumbea*, Fowler, H. W., *Proc. 4th Pac. Sci. Congr., Java*, 1929 3, 1930: 492 (? Mazatlan record).

*Discussion:* The 704 mm. specimen that we refer to this species agrees well with the description of the 915 mm. type, except for the following: there is but one gill-opening definitely over the pectoral base, and the anterior margin of the pelvic fins is shorter than the distance between the angles of the mouth. However, the general agreement is so close that we have no hesitation in assigning our Costa Rican specimen to *fronto*.

In the original description of *fronto*, based on an adult and a young shark, it is obvious that two species are represented, the first half of the description referring to a fish with an exceptionally large second dorsal fin and narrowly triangular, broad-based teeth. The second half of the



description, in which the body-measurements are admittedly inaccurate, as they were made without instruments, is of a ten-foot shark with much smaller second dorsal fin and serrated teeth. The latter fish may represent a specimen of *Eulamia azureus*. We here delimit the first half of this description, referring to the small specimen designated as the type, as the original description of *fronto*.

Our transfer of the species to the genus *Aprionodon* is based upon the following. Jordan & Gilbert in the original description of *fronto* state: "Edges of teeth appearing minutely serrulate under a lens." This condition is not true of our specimen as even under fairly high power the tooth edges are entire *except* where their rather delicate borders have become irregularly nicked from some external agency.

In order to check on this discrepancy, Dr. Leonard P. Schultz of the U. S. National Museum was asked to examine the teeth of the type specimen of *Carcharias fronto*. He reports: ". . . the teeth do not have serrations, only rough here and there from some external cause."

We thus have evidence from the type and an additional shark that the teeth are smooth and we consequently assign the species to *Aprionodon*. It may be mentioned that *Aprionodon fronto* differs considerably in appearance from the species of *Eulamia* found along the tropical Pacific coast, the similarity in size of the two dorsal fins giving the fish a distinctive appearance. In this it resembles the Atlantic *Hypoprion brevipinnis* and some of the western Pacific species of *Aprionodon*.

Probably as the result of true *fronto* being considered as the young of a large, serrated-toothed shark (a natural conclusion, considering the inference supplied by the two specimens in the original description), Garman synonymized this species and the eastern Pacific *Eulamia azureus* with the Atlantic Ocean *Eulamia milberti*. In this he has been followed by other authors.

### *Eulamia* Gill, 1861.

#### Key to tropical eastern Pacific species.<sup>18</sup>

- 1a. Sides of the body with a band-like continuation of the dark color of the upper surfaces extending backward along the sides to above the pelvic fins, enclosing above it a section of the white of the underparts; tips of fins black; teeth of both jaws narrowly triangular with a broad shoulder-like base, all of the teeth distinctly serrated on their margins; lower teeth considerably narrower than the upper. *aethalorus*
- 1b. Color pattern not as above. Teeth, especially those of the upper jaw, not as above, either broadly triangular, or with one side notched, or with a broad shoulder-like base on one side only.
- 2a. Snout exceptionally long and thin; inter-narial space equal to or only slightly exceeding the length of one of the nostrils; nostril openings almost transverse. . . . . *velox*

- 2b. Snout not especially long and narrow; inter-narial space at least two and a half times or more as broad as the length of a nostril.
- 3a. Origin of the 2nd dorsal fin opposite or behind the vertical of the *middle* of the anal fin. . . . . *cerdale*
- 3b. Origin of the 2nd dorsal fin opposite or in advance of the *origin* of the anal fin.
  - 4a. Snout short and bluntly rounded, the preoral portion 1.66 to 1.9 in the distance between the angles of the mouth; origin of the 2nd dorsal fin conspicuously in advance of that of the anal fin. *azureus*
  - 4b. Snout not as short and blunt, the preoral portion slightly less to slightly longer than the width of the mouth, not as short as mentioned above; origin of the 2nd dorsal fin slightly in advance of that of the anal, or directly above.
  - 5a. Teeth finely serrate, not notched; origin of the 2nd dorsal fin slightly in advance of the origin of the anal fin. *lamiella*
  - 5b. Teeth coarsely serrate, usually notched; origin of 2nd dorsal fin approximately above that of the anal.
    - 6a. Tips of some of the fins white. *platyrhynchus*
    - 6b. Tips of the fins dusky, never white. *galapagensis*

### *Eulamia aethalorus* (Jordan & Gilbert).

Cazon.

(Plate II, Fig. 2).

*Range:* Pacific mainland from Lower California and the Gulf of California to Peru. (Mexico: Concepcion Bay, La Paz, Arena Bank, Mazatlan; Guatemala: Chiapam; Panama: Panama Bay; Peru: Lobos de Afuera Island).

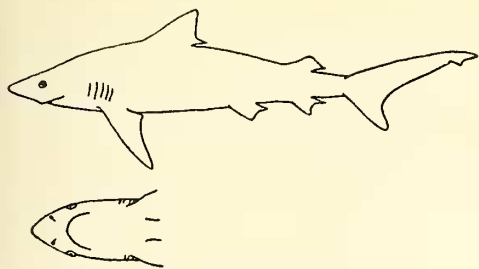
*Field Characters:* A medium-sized shark with conspicuous black tips to the fins and a dark band along the sides as far back as the pelvic fins, enclosing above it a section of the white underparts. Teeth of the jaws narrowly triangular with broad, shoulder-like basal portions; upper teeth finely serrate, lower teeth almost

<sup>18</sup> The difficulties of identifying some of the species of this genus have long been manifest, and during the *Zaca* and *Arcturus* expeditions this fact was appreciated more than ever when sharks too large to preserve were caught. While working over our preserved material, it became even more evident that the synonymies and concepts of the species of *Eulamia* of the Pacific were far from being clean-cut and exact.

In an attempt to straighten out the confusion that existed in our minds while reviewing the literature of the sharks of the eastern tropical Pacific, we decided to discard all references that merged the eastern Pacific forms with species of supposedly world-wide distribution and to start over again with types and original descriptions of the species that have been described from the region under discussion. We have not attempted to recorelate the eastern Pacific forms with species from other regions. These littoral species seem to represent valid local species.

The change with age of many characters in this group is considerable, and because of this we have given the exact length of each specimen discussed.

Two imperfectly described species that apparently belong to the genus *Eulamia* are described from the west coast of South America. We have not been able to satisfy ourselves as to their relationships. They are *Carcharias robustus* Philippi (*Ann. Univer. Chile*, 93, 1896: 389) and *Eulamia philippi* Fowler, described as *Carcharias brachyrhynchus* by Philippi (*Ann. Univer. Chile*, 71, 1887: 540) and renamed by Fowler.



Text-figure 15.

smooth. (Illustration after Meek & Hildebrand, 1923: 850 mm.)

*Color:* Dusky bronze above; dead white on lower snout, head and lower surfaces of the pectoral fins; belly, first dorsal and anal fins grayish; the dusky bronze covers the upper surface of the pectoral fins and extends back in a long narrowing band along the lower sides to above the pelvic fins, enclosing a wider band of whitish from the sides of the peduncle forward, dying out at the vertical of the center of the first dorsal fin. Pelvic fins above, and caudal fin bronzy dusky like the back. Paired fins white below with jet black tips, the black extending down the posterior edge of the pectorals. Posterior edge of the first dorsal black; distal half of second dorsal black; posterior edge of caudal black. Anal fin pale with a large black spot at the tip. Iris pale brassy. (2,070 mm. fish.)

In the embryos from the specimen just described, the color pattern of the sides is even more marked than in the adult. They also possess conspicuously black-tipped fins.

*Size and Weight:* Grows to at least seven feet. A 2,070 mm. (81 inches) shark weighed 123 pounds. A 630 mm. embryo weighed 3 pounds.

*Parasites:* Eighteen copepod parasites, *Alebiaon* sp. taken from this species plus a specimen of *Racineia aries*, from the gills.

*Food:* This shark took dolphin-fish bait while it was associated with several other sharks in the vicinity of a school of hundreds of large crevalle (*Caranx caninus*). In the stomach of the shark were 24 California sardines (*Sardinia caerulea*).

*Breeding:* Four embryos averaging 630-650 mm. in length were taken from the 2,070 mm. adult; they were close to being born.

These full-grown embryo sharks were roughly one-third the total length of the adult. Twenty-four comparative measurements of mother and young showed a slight increase in the embryos in relative lengths of the predorsal part of the fish, such as snout to mouth, snout to pectoral, snout to first dorsal fin. The eye was somewhat larger. The pectorals were slightly smaller as was the second dorsal, and the depth was proportionately less. On the whole, however, there was an astonishing agreement in the proportions of the mother and unborn offspring.

This absence of marked dissimilarity in proportions seems to find its explanation in the total lack of larval or real adolescent life. These embryos, when freed from the mother and the umbilical cord, straightway swam off, showing perfect correlation, avoiding the sides and bottom of a large tub, snapping at anything offered to them and apparently functioning in almost every way that a shark requires in order immediately to begin a successful career in the open sea. At the first impact of the outside world these embryos are perfect sharks in miniature, quite unlike the condition of those fish which hatch from eggs near shore or the bottom of shallow waters.

*Study Material:* 4 specimens. Mexico: Arena Bank, Lower California, 3, adult female (teeth saved) and two young (25,471, 25,472, 25,472B.), 2,070, 630, 650 mm., April 30, 1936, adult captured on rod and line with sailfish bait; 1, Concepcion Bay, Lower California (U. S. Nat. Mus. 46851), collected by the *Albatross*.

*References:* *Carcharias aethalorus*, Jordan, D. S. & Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 5, 1882: 104 (original description, color; type-locality: Mazatlan, Mexico). Jordan, D. S. & Gilbert, C. H., *Bull. U. S. Fish Comm.*, 2, 1882: 105 (Mazatlan, Mexico), 109 (Panama). Gilbert, C. H. & Starks, E. C., *Fishes of Panama Bay*, 1904: 9 (teeth, claspers, proportions; Panama), 207 (distribution, Gulf of California).

*Carcharhinus aethalorus*, Jordan, D. S., *Proc. U. S. Nat. Mus.*, 8, 1885 (1886): 363 (check-list). Jordan, D. S., *Fishes of Sinaloa*, 1895: 383 (relationship with *limbatus*). Jordan, D. S. & Evermann, B. W., *Fishes of North and Middle America*, 1, 1896: 40 (description, range).

*Carcharhinus aethalorus*, Garman, S., *Bull. Mus. Comp. Zool.*, 46 (12) 1906: 229 (Panama).

*Carcharias limbatus*, Günther, A., *Cat. Fishes Brit. Mus.*, 8, 1870: 373-374 (Reference to specimen from Chiapam only: Guatemala; refers to *maculipinnis* reference).

*Carcharhinus limbatus*, Garman, S., *The Plagiostomia*, 1913: 127 (synonymy referring to *aethalorus*).

*Carcharhinus limbatus*, Pellegrin, J., *Bull. Mus. Hist. Nat. Paris*, 7, 1901: 161 (Gulf of California). Nichols, J. T. & Murphy, R. C., *Bull. Amer. Mus. Nat. Hist.*, 46, 1922: 504 (jaw from Lobos de Tierra, Peru). Meek, S. E., & Hildebrand, S. F., *Marine Fishes of Panama*, 1, 1923: 41 (description; synonymy referring to *aethalorus*; Panama).

*Carcharhinus natator*, Meek, S. E. & Hildebrand, S. F., *Marine Fishes of Panama*, 1, 1923: 41, Plate 1, fig. 1 (original description, color, figure; type locality, Panama City, Panama; type No. 79310, U. S. Nat. Mus.).

*Carcharias maculipinna* (not of Poey) Günther, A., *Trans. Zool. Soc. London*, 6, 1868: 490, teeth, dimensions; Guatemala, Chiapam.

*Discussion:* We have two embryos of this species at hand that agree excellently with the original description of *aethalorus*, and the teeth,



field description, measurements and photographs of the 2,070 mm. parent; these specimens were taken at Arena Bank, Lower California, 160 miles N. by W. of Mazatlan, the type locality of the species. The embryos differ from the original description in having the base of the first dorsal fin slightly greater than the height (the opposite is true of the parent) and in the caudal fin being 29% of the length instead of 25% (the parent has the same measurement 27%).

Comparing the adult female with the original description of *aethalorus*, which is of a male 30 inches or 762 mm. in length, the following slight differences are observed: the preoral distance is 81% of the mouth width instead of being equal; the teeth are  $\frac{30}{30}$  instead of  $\frac{24}{24}$  (Panama specimens are recorded as  $\frac{29}{29}$ ; the base of the first dorsal is 1.2 in the interorbital width, not equal; the second dorsal fin base is 5.2 instead of 4 in the interdorsal space; the base of the 2nd dorsal fin is 36% (instead of 50%) of the base of the first dorsal (in our embryos this distance is approximately 50%).

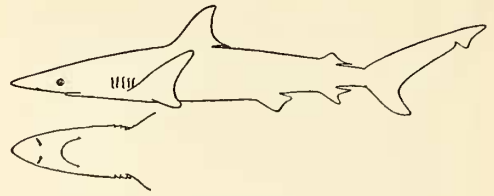
*Carcharinus natator*, described by Meek & Hildebrand from Panama Bay, we believe to be identical with *aethalorus*. The characters differentiating the two forms overlap when our embryos and large specimens are compared with the descriptions. *Eulamia aethalorus* and *natator* both possess the same type of teeth, general proportions and relationships of fins. It must be admitted that our specimens do not show the peculiar form of the snout, when viewed from the side, that is shown for *natator* in Meek & Hildebrand's original illustration of their type. This peculiar conformation may have been caused by preservation.

As far as coloration is concerned the two forms are the same. Both have conspicuous black-tipped fins and possess a distinctive color pattern on the sides. In the original description of *natator* two ill-defined dark bands are mentioned, and in our two Gulf of California specimens these bands are strongly evident. However, the uppermost of these two bands is merely an intensification of the lower border of the dark pigmentation of the dorsal surfaces and in the adult female this band has completely merged with the dark of the upper surfaces, leaving only the shorter, lower band conspicuously outlined. This band is mentioned above in the description under *Color* and can indistinctly be seen in the illustration; it was plainly visible in life and is so mentioned in our field notes.

This shark is closely related to *Eulamia limbatus* of the Atlantic.

*Eulamia velox* (Gilbert).

(Plate II, Fig. 3).



Text-figure 16.

*Range:* Lower California, Costa Rica and Panama Bay. (Mexico: Santo Domingo Point and Cape San Lucas, Lower California; Costa Rica: Port Culebra; Panama: Panama Bay. Previously known from three specimens taken in Panama Bay; our two specimens extend the range some 2,100 miles northeastward along the coast.)

*Field Characters:* A small elongate shark with a long narrow snout; nostrils large, the interdorsal space narrow, about equal, more or less, to the relatively large nostril openings. (Illustration after Gilbert & Starks, 1904: 1200 mm.)

*Color:* Bronzy brown above, changing to silvery iridescence and dead white below. Second dorsal fin with a dusky tip.

*Size:* The largest recorded specimen is 1,200 mm. (47½ inches).

*Food:* The stomach of our Santa Domingo specimen contained the chelae of a crab, *Ovalipes punctatus*.

*Study Material:* 3 specimens. Mexico: Santo Domingo Point, Gulf of California, 1 female (25264), 945 mm., April 16, 1936, hand-line; San Lucas Bay, Lower California, 1, April 23, 1936, hand-line. Costa Rica: Port Culebra, 1 female (26134) 735 mm., Jan. 25, 1938.

*References:* *Carcharhinus velox*, Gilbert, C. H., in Jordan, D. S. & Evermann, B. W., Fishes North and Middle America, 3, 1898: 2747 (original description, color; type locality, Panama; type, No. 11893, University Museum, Stanford University). Meek, S. E. & Hildebrand, S. F., Marine Fishes of Panama, 1, 1923: 45 (description, Panama market).

*Carcharias velox*, Gilbert, C. H. & Starks, E. C., Fishes of Panama Bay, 1904: 5 (deposition of type) 9, Plate 1, fig. 3 (copy of original description, figure), 207 (distribution).

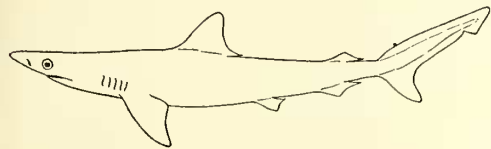
*Carcharinus velox*, Garman, S., The Plagiostomia, 1913: 130 (description).

*Discussion:* These are the fourth, fifth and sixth recorded specimens of this rare species. The previously known ones are the type, taken by



Gilbert in Panama Bay, and two specimens taken by Meek & Hildebrand, also at Panama. The present specimens agree perfectly with Gilbert's description of a 1,200 mm. fish and with the description given by Meek & Hildebrand.

*Eulamia cerdale* (Gilbert).



Text-figure 17.

*Range:* Mexico to Ecuador and the Galápagos Islands. (Mexico: "coast of Mexico"—Kumada & Hiyama; Panama: Panama Bay, and at sea 130 miles S. W. of Burica Point, Panama; Colombia: Buenaventura; Ecuador: Guayaquil; Galápagos Islands, South Seymour and Albe-Marle. Also known, according to Meek & Hildebrand, from the Atlantic side of the Isthmus of Panama.)

*Field Characters:* A small shark lacking conspicuous folds and grooves about the angles of the mouth and with the origin of the 2nd dorsal fin at or behind the vertical of the middle of the anal fin; teeth serrate, those in the upper jaw broader and more oblique than those in the lower and with broader bases; a rather prominent notch behind the large triangular cusp of the lateral teeth in the upper jaw. Bluish-gray above, pale below. (Illustration after Kumada & Hiyama, 1937: 537 mm.)

*Size:* Herre's largest specimen was 1,235 mm. (49 inches). This, judging by Meek & Hildebrand, is a small species.

*Study Material:* 1 specimen, Panama (U. S. Nat. Mus. 50438) collected by Gilbert.

*References:* *Carcharinus* sp. indes., Jordan, D. S., *Proc. U. S. Nat. Mus.*, 8, 1885 (1886): 363 (name only; specimens destroyed by fire before publication of description).

*Carcharhinus cerdale*, Gilbert, C. H., in Jordan, D. S. & Evermann, B. W., *Fishes of North and Middle America*, 3, 1896: 2746 (original description, color, abundance, comparison with *aethalorus*; type locality: Panama; type No. 11,884, University Museum, Stanford University). Meek, S. E. & Hildebrand, S. F., *Marine Fishes of Panama*, 1, 1923: 47 (description, synonymy, color, discussion of Atlantic coast relative, range).

*Carcharias cerdale*, Gilbert, C. H. & Starks, E. C., *Fishes of Panama Bay*, 1904: 5 (number and disposition of type), 10, Plate 2, fig. 4 (description, color, abundance, comparison with *aethalorus*, figure; Panama). Starks, E. C., *Proc. U. S. Nat. Mus.*, 30, 1906: 762 (range), 763 (Ecuador).

*Carcharinus cerdale*, Garman, S., *Bull. Mus. Comp. Zool.*, 46, 1906: 229 (Panama). Herre,

A. W., *Field Mus. Nat. Hist., Zool. Ser.*, 21, 1936: 22 (synonymy, short description, color, size; Galápagos Islands and at sea).

*Charcharhinus cerdale*, Wilson, C., *Ann. Carn. Mus.*, 10, 1916: 58 (Colombia, Ecuador).

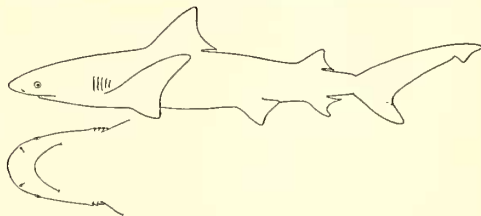
*Eulamia cerdale*, Fowler, H. W., *Acad. Nat. Sci. Phila., Monograph No. 2*, 1938: 249 (mentioned in check-list of Galápagos Island fishes).

*Carcharinus menisorrah* (in part) Garman, S., *The Plagiostomia*, 1913: 135 (synonymy referring to *cerdale* only).

*Carcharhinus lamiella* (not of Jordan & Gilbert), Kumada, T., & Hiyama, Y., *Marine Fishes Pacific Coast of Mexico*, 1937: 16, Plate 48 (short description, referring to almost any shark; figure referable to *cerdale*).

*Discussion:* The figure of Kumada & Hiyama agrees almost entirely with the original figure of *cerdale*, and even though this record extends the distribution of the species to an indefinite locality on the coast of Mexico, we consider this extension justified.

*Eulamia azureus* (Gilbert & Starks).



Text-figure 18.

*Range:* Mexico ?, Costa Rica, Panama and Ecuador. (? Mexico: Mazatlan; Costa Rica: Piedra Blanca Bay; Panama: Panama Bay; Ecuador: Guayaquil.)

*Field Characters:* A large shark with broadly rounded head and with the origin of the 2nd dorsal fin well in advance of that of the anal; teeth of the upper jaw broadly triangular with their inner margins oblique and usually slightly convex, the outer margins concave or sometimes with a very slight notch; lower jaw with much narrower, triangular teeth on a broad base; upper jaw teeth serrate along entire border, lower teeth more finely serrate, the serrations less prominent and sometimes absent on the shoulders of the teeth. (Illustration after Gilbert & Starks, 1904: 920 mm.)

*Color:* Dark gray above, white below; fins with dusky tips.

*Size and Weight:* Our 2,820 mm. (9 feet, 3 inches) shark weighed 210 pounds.

*Food:* This species at times feeds upon sting rays, as the spines of four of these animals were found embedded in the skin of the jaws of our shark.

*Parasites:* Two leeches, *Pontobdella muricata* (Linn.), were taken from our Piedra Blanca

shark. A copepod parasite, *Rocinela aries*, taken from the gills.

*Study Material:* 2 specimens. Costa Rica: Piedra Blanca Bay, 1 male (26148), 2,820 mm., Feb. 4, 1938, harpooned. Ecuador: Guayaquil, 1 male (U. S. Nat. Mus. 53528) 1025 mm.

*References:* *Carcharias azureus*, Gilbert, C. H. & Starks, E. C., *Fishes of Panama Bay*, 1904: 5 (type and disposition), 11, Plate 2, fig. 5 (original description, color, figure; type locality, Panama; type No. 11884, University Museum, Stanford University; comparison with *C. nicaraguensis*; size of male with undeveloped claspers), 207 (distribution). Starks, E. C., *Proc. U. S. Nat. Mus.*, 30, 1906: 762 (distribution), 763 (Guayaquil, Ecuador; specimen compared with type). Garman, S., *Bull. Mus. Comp. Zool.*, 46, 1906: 229 (Panama).

*Carcharias milberti*, Garman, S., *The Plagiostomia*, 1913: 133 (references referring to *azureus* only; not description). Meek, S. E. & Hildebrand, S. F., *Marine Fishes of Panama*, 1, 1923: 38 (references referring to Pacific specimens and description of Ecuadorian skin on pp. 39-40; description).

*Eulamia plumbea*, ? Fowler, H. W., *Proc. 4th Pac. Sci. Congr., Java* 1929, 3, 1930: 492 (? Panama record).

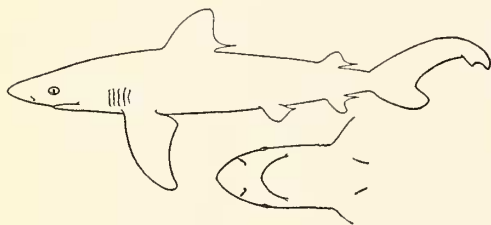
*Discussion:* We have had for comparison with our Costa Rican specimen, the 1,025 mm. shark recorded by Starks from Ecuador; we find that they are the same. The Ecuadorian shark was compared with the type by Starks and partially redescribed by Meek & Hildebrand.

The large specimen recorded under the original description of *Carcharias fronto* (*Proc. U. S. Nat. Mus.*, 5: 103-104) may be this species. As is stated, all of the measurements were taken without instruments and are questionable. However, there are no strong points of difference and the description of the teeth is in agreement with our specimen.

This species is closely related to the Atlantic *Eulamia milberti*.

*Eulamia lamiella* (Jordan & Gilbert).

Bay Shark; Tiburon.



Text-figure 19.

*Range:* Southern California to the Gulf of California. (Mexico: Concepcion Point and Mazatlan.)

*Field Characters:* Broad-snouted shark growing to 15 feet, with origin of the 2nd dorsal fin slightly in advance of that of anal, preoral portion of the snout slightly less or slightly greater than the width of the mouth; teeth triangular, not notched, with fine serrations; grayish, tips of the pectoral fins slightly dusky. (Illustration from specimen No. 25263: 840 mm.)

*Color:* Dark gray above, grayish-white below; no markings; tips of the pectorals slightly dusky, the upper side dark; all other fins plain.

The color of six embryos averaging 840 mm. in length, was as follows: Above slaty-black with sheen; dead white below; sides iridescent, changing from purplish to bronze to silvery; first dorsal dark bronze-gray, upper posterior margin broadly black; second dorsal same with the distal half black, dark at base with large, black distal spot, white below with corresponding distal black spot; pelvics pale gray with black tip; anal same with larger black spot; caudal with entire outline narrowly jet black, tips of lobes black, the rest gray. Iris silvery with greenish tinge.

*Size and Weight:* Grows to 15 feet. A 2,616 mm. (8 foot 6 inch) shark weighed 270 pounds.

*Abundance:* Rare north of San Diego, fairly common in San Diego Bay and southward.

*Parasites:* Five copepod parasites, *Alembion* sp., taken from this species.

*Breeding:* Our 2,616 mm. female had six young on April 16, 1936, about to be born. The young averaged around 840 mm. in length and were from 4 pounds 4 ounces to 8 pounds 12 ounces in weight. The litter was composed of one male and five females.

*Study Material:* 3 specimens. Mexico: Concepcion Point, Lower California, 1 adult female, not saved (25262) and 1 embryo, saved (25263), 2,616 and 840 mm., April 16, 1936, caught on hook and line. The type in the U. S. National Museum was also examined.

*References:* *Eulamia lamia*, Jordan, D. S., & Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 4, 1881: 32 (First recording of specimen which later became the type of *lamiella*).

*Carcharias lamiella*, Jordan, D. S., & Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 5, 1882: 110 (original description, color; type locality, San Diego, California; type, No. 27366, U. S. Nat. Mus.).

*Carcharhinus lamiella*, Jordan, D. S., *Fishes of Sinaloa*, 1895: 382 (Mazatlan, Mexico; deformed tail). Jordan, D. S., & Evermann, B. W., *Fishes North and Middle America*, 1, 1896: 37 (description; range).

*Carcharhinus commersonii* (in part), Garman, S., *The Plagiostomia*, 1913: 140 (synonymy referring to *lamiella* only). Meek, S. E., & Hildebrand, S. F., *Marine Fishes of Panama*, 1, 1923: 43 (synonymy referring to *lamiella* only, not description).

*Eulamia commersonii* (in part), Fowler, H. W.,



*Proc. 4th Pac. Sci. Cong., Java, 1929 (1930):* 493 (localities referring to *lamiella* only; references include *platyrhynchus*).

*Discussion:* The relationship of this species, and of *platyrhynchus* and *galapagensis* are not as clearly defined as might be desired. Thus we find that the original description of *platyrhynchus* states the following: "From *lamiella* it differs in the notched teeth and the anterior position of the first dorsal." The type of *lamiella*, however, is not in accord with its original description and the first dorsal fin is much further forward than is stated. It is actually the same in position in both species. Relative fin positions are thus invalid as distinguishing specimens of *lamiella* and *platyrhynchus*.

The teeth serrations in the two species constitute a real difference. Thus in *lamiella*, of which we have examined adult and young in addition to the young type, the serrations on the teeth are very fine, while in the more or less equal-sized specimen of *platyrhynchus* and the eight specimens of the closely related *galapagensis* the serrations are exceptionally coarse.

As far as *galapagensis* and *platyrhynchus* are concerned, the original description of the former states: "The same in every respect as *Carcharias platyrhynchus* (Gilbert) except that the fins at all ages are of uniform coloration with the body, being never margined with white." In the materials that we have examined the presence or absence of white fin tips is clearly demonstrable, and the specimens are easily assigned to one species or the other on that basis, but the materials also indicate that further studies are needed involving series of young and old before these two forms are clearly defined. There seems to be considerable variation in our series of *galapagensis*, but owing to differences in size and lack of pertinent sized material we are unable to correlate these variations.

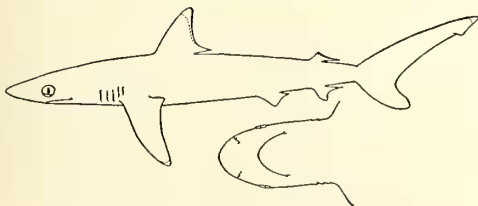
It is of interest that, so far, all locality records of *lamiella* are continental, while those of *platyrhynchus* and *galapagensis*, with the exception of a single questionable continental record for each species, are off-shore and insular.

*Carcharhinus lamiella* possesses a low dermal keel between the first and second dorsal fins.

This species has usually been synonymized under the Atlantic and Mediterranean *Eulamia commersonii*.

### *Eulamia platyrhynchus* Gilbert.

White-tipped Shark.



Text-figure 20.

*Range:* Mexico: Magdalena Bay and Mazatlan (?), Revillagigedo Islands; Cocos Island, Clipperton Island, Galápagos Islands and at sea, 230 miles N. W. of Clipperton Island.

*Field Characters:* Small to medium-sized, broad-snouted sharks with the origin of the 2nd dorsal fin approximately above that of the anal; teeth of the upper jaw triangular with the outer margin notched or concave, serrated; lower teeth erect, narrow, serrulate. Gray, with the tips of the dorsal, pectoral and caudal fins tipped with white. (Illustration from Specimen No. 17,521, Field Museum; 700 mm.)

*Color:* Dorsal fins, sometimes only the first dorsal, tipped with white; occasionally with the dorsal and pectoral fins tipped and posteriorly bordered with white, the marginal parts of the fins pale.

*Size:* Grows to nine feet.

*Abundance:* A locally abundant fish. Beebe reports 16, five- to six-foot sharks seen while diving in one spot at Cocos Island.

*Food:* Fish; a new species, *Pontinus strigatus*, was taken from the stomach of this species. There is also a record of *Diodon hystrix*.

*Study Materials:* 2 specimens. Clarion Island, 1 male (25594) 1,524 mm., May 10, 1936, hand line, teeth preserved and photograph. 1, Tagus Cove, Galápagos Islands, 700 mm. (Field Mus. Nat. Hist. 17521), Jan. 9, 1929.

*References:* *Eulamia (Platypodon) platyrhynchus*, Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 14, 1891: (1892): 543 (original description: part refers to *galapagensis*: Clarion Island, Magdalena Bay).

*Carcharias platyrhynchus*, Snodgrass, R. E., & Heller, E., *Proc. Wash. Acad. Sci.*, 6, 1905: 344 (Clarion Island, near Clipperton Island, color note), 414 (280 mm. *Diodon hystrix* from stomach). Beebe, W., *The Areturus Adventure*, G. P. Putnam's Sons 1925: 246, 435 (sociability), 302, 435 (habits) 412 (Cocos Island).

*Carcharinus platyrhynchus*, Herre, A. W., *Field Mus. Nat. Hist., Zool. Ser.*, 21, 1936: 23 (brief note on proportions, color and abundance; Cocos and Galápagos Islands).

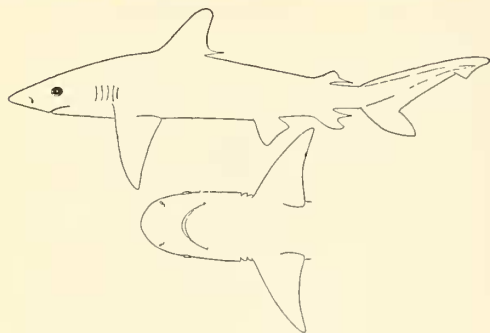
*Carcharhinus platyrhynchus*, Jordan, D. S., & McGregor, R. C., *Rep't. U. S. Fish Comm.*, 1898 (1899): 274 (Clarion Island). Jordan, D. S. & Evermann, B. W., *Fishes North and Middle America*, 1, 1896: 36 (description in part, remainder belongs to *galapagensis*). Heller, E., & Snodgrass, R. E., *Proc. Wash. Acad. Sci.*, 5, 1903: 209 (Galápagos Is., type of *Pontinus strigatus* taken from stomach).

*Carcharinus commersonii* (in part) Garman, S., *The Plagiostomia*, 1913: 140 (synonymy referring to *platyrhynchus* only). Meek, S. E., & Hildebrand, S. F., *Marine Fishes Panama*, 1, 1923: 43 (synonymy referring to *platyrhynchus*).

*Carcharias* sp. incog., Jordan, D. S., & Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 5 1882 (1883): 107 (teeth of Mazatlan fish, may refer to this species).

*Discussion:* See under *C. lamiella*.



*Eulamia galapagensis* (Snodgrass & Heller).

Text-figure 21.

*Range:* Mexico: Lower California (?), Clarion Island; Clipperton Island; Cocos and Galápagos Islands; and at sea 75 miles northeast of Malpelo Island.

*Field Characters:* Small to medium sized, broad-snouted sharks with the 2nd dorsal fin origin approximately above that of the anal. Teeth of the upper jaw triangular, notched or concave on the outer margin and strongly serrated. Lower teeth, narrow, erect, with much smaller serrations. Color uniform gray, the tips of the fins dusky, never tipped with white. (Illustration from specimen No. 5257: 798 mm.)

*Color:* Iris silvery-gray.

*Abundance:* Herre states: "This shark swarms in the waters of the Galápagos Islands and about Cocos Island. I have never seen sharks of this genus in such abundance as in these two localities. A great many of this species were caught by hook and line or harpooned. . ."

*Size and Weight:* Grows to 8 feet. A 790 mm. (31 inches) fish weighed 7 pounds and a 1,260 mm. (50 inch) shark weighed 24 pounds.

*Study Material:* 8 specimens. Clarion Island, 3 males and 1 female (25498, 25674, 25675, 25676; 590, 735, 768 and 842 mm.) May 10, 1936, hook and line and harpooned. Tower Island, Galápagos Islands, 2 (5254, 5257) 790, 798 mm., April 8, 1925, harpooned. Galápagos Islands, 2 (Field Museum No. 17520) Jan. 9, 1929. Cocos Island, 1 (Field Museum No. 17519), Jan. 2, 1929.

*References:* *Carcharias galapagensis*, Snodgrass, R. E., & Heller, E., *Proc. Wash. Acad. Sci.*, 6, 1905: 343 (original description; short synonymy; range, size, food; type locality: Galápagos Islands; type No. 12324, University Museum, Stanford University) Beebe, W., *The Arcturus Adventure*, G. P. Putnam's Sons, New York, 1926: 184, 302 (color of eye), 412 (4-foot specimen harpooned, food; Galápagos Islands).

*Eulamia galapagensis*, Fowler, H. W., *Proc. U. S. Nat. Mus.*, 80 (6) 1932: 1 (teeth; Galápagos Islands). Fowler, H. W., *Acad. Nat. Sci. Phila., Monograph No. 2*, 1938: 13 (jaw and ventral fins of female from 75 miles northeast of Malpelo

Island), 19 (references; jaws, ventral fins and section of skin; Galápagos Islands), 248 (check-list; range among Galápagos Islands).

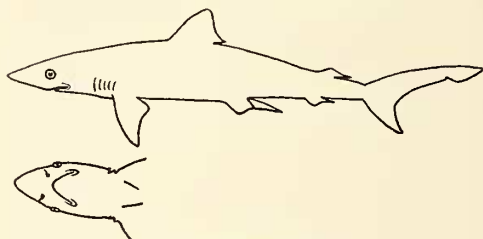
*Carcharinus galapagensis*, Herre, A. W., *Field Mus. Nat. Hist., Zool. Ser.*, 21, 1936: 22 (color, abundance, size; Galápagos and Cocos Islands).

*Eulamia lamiella* (?), Jordan, D. S., & Bollman, C. H., *Proc. U. S. Nat. Mus.*, 12, 1889: 179 (name only; Galápagos Islands).

*Eulamia (Platyodon) platyrhynchus* (in part), Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 14, 1891 (1892): 543 (non-white-margined specimens; Revillagigedo Islands).

*Carcharhinus platyrhynchus*, Jordan, D. S., & Evermann, B. W. (in part), *Fishes North and Middle America*, 1, 1896: 36 (part of description referring to *galapagensis*).

*Discussion:* See discussion under *lamiella*.

*Scoliodon* Müller & Henle, 1837.*Scoliodon longurio* (Jordan & Gilbert).

Text-figure 22.

*Range:* Gulf of California, and coast of Mexico, Panama. (Mexico: Santa Inez Bay, Guaymas, Mazatlan, San Lucas Bay, Banderas Bay, Tangola-Tangola; Panama: Panama Bay.)

*Field Characters:* A small, sharp-snouted shark with origin of the second dorsal fin above or posterior to the middle of the base of the anal fin; conspicuous labial fold and groove at the angle of the mouth, paralleling the jaw and extending forward about one third the distance from the gape to the front of the mouth. (Illustration after Meek & Hildebrand, 1923.)

*Color:* Gray with a bluish tinge above, white below; tips of fins margined with dusky.

*Size and Weight:* Grows to 1,068 mm. (42½ inches). A specimen of this size weighed nine pounds.

*Local Distribution:* All of the records and our specimens seem to indicate that this is a bay shark.

*Abundance:* Locally abundant, based on Jordan's and our experiences.

*Study Materials:* 2 specimens. Mexico: Santa Inez Bay (24,993) 980 mm., April 13, 1936, hand-line; Puerto Vallarte, Banderas Bay, 1 (27,054), 815 mm., Nov. 15, 1937, hand line (teeth saved). We have also examined six specimens from San Lucas Bay, and an additional one from Santa Inez Bay.

*References: Carcharias longurio*, Jordan, D. S., & Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 5, 1882: 106 (original description, color; type locality: Mazatlan, Mexico; types, Nos. 28,306, 28,330, 28,331, 29,451, 29,551, U. S. National Museum).

*Carcharhinus longurio*, Jordan, D. S., *Proc. U. S. Nat. Mus.*, 8, 1885 (1886): 363 (check-list).

*Scoliodon longurio*, Jordan, D. S., & Gilbert, C. H., *Bull. U. S. Fish. Comm.*, 2, 1882: 105 (Mazatlan, Mexico). Evermann, B. W., & Jenkins, O. P., *Proc. U. S. Nat. Mus.*, 14, 1891 (1892): 130 (references; Guaymas, Mexico). Jordan, D. S., *Fishes of Sinaloa*, 1895: 382 (common at Mazatlan). Jordan, D. S., & Evermann, B. W., *Fishes North and Middle America*, 1, 1896: 42 (description). Jordan, D. S., & Evermann, B. W., *Fishes North and Middle America*, 3, 1898: 2748 (note on teeth and size of first dorsal). Gilbert, C. H., & Starks, E. C., *Fishes of Panama Bay*, 1904: 12 (6 specimens from Panama; note on proportions and teeth), 207 (range; Panama and Gulf of California). Garman, S., *The Plagiostomia*, 1913: 114 (short synonymy, description, color; range). Meek, S. E., & Hildebrand, S. F., *Marine Fishes of Panama*, 1, 1923: 52, Plate 2, fig. 1 (short synonymy, description, color, figure, comparison with types, claspers; Panama fish market, 525 and 700 mm. males). Breder, C. M., Jr., *Bull. Bingham Oceanogr. Coll.*, 2 (1), 1928: 3 (specimen from unknown locality). Seale, A., *Allan Hancock Pacific Expeditions*, 9 (1), 1940: 1 (490 mm. specimen, Tangola-Tangola, Mexico).

deep notch and coarsely serrated edges, the tips turned obliquely outward. (Illustration after Norman, 1937.)

*Color:* Dark gray above, white below; numerous black, rectangular spots on body and fins, usually forming vertical bars, becoming rounded on upper caudal lobe. This pattern is lost on older individuals. Iris greenish-brown.

*Size:* Reaches a length of at least 20 feet (Record of 30 feet unconfirmed).

*Weight:* A shark of 1,625 mm. (5 feet, 4 inches) weighed 137 pounds; 1, 3,073 mm. (10 feet, 1 inch) 366 pounds (liver 97 lbs. 26% of whole); 1, 3,200 mm. (10 feet, 6 inches) 505 pounds; 1, 3,886 mm. (12 feet, 9 inches) 780 pounds (liver 188 lbs., 24% of whole).

*Local Distribution:* Well offshore and in bays of only four fathoms depth.

*Abundance:* Tiger sharks are fairly common throughout the area under consideration.

*Food:* Almost any invertebrate or vertebrate of sufficient size may find a place in the diet of this shark. Our list is as follows: garbage (3 stomachs), octopus (400 mm.), *Heterodontus quoyi* (375 mm.), sting rays (7 in 3 stomachs, four of them *Urobatis halleri*), *Gymnosarda alletterata* (400 mm.), *Mycteroperca jordani* (600 mm.), *Diodon holacanthus* (200 mm.), *Ogcocephalus* sp. (150 mm.), *Iguana iguana* (1,371 mm.), *Chelone mydas*, full of eggs (760 mm.), feathers (3 stomachs), 2 Clarion shearwaters, *Puffinus auricularis*; and Galápagos sea-lion pup, *Otaria jubata*.

*Parasites:* Two copepods taken from near the gills, *Pandarus satyra* Dana and *Rocincla arics*.

*Study Material:* Definite notes were made on 11 tiger sharks, and several other individuals were seen. All were hooked from the deck of vessels. Mexico: Santa Inez Bay, 1 (24,894), 1,625 mm., April 9, 1936; Santa Inez Bay, 1, 1,422 mm., April 9, 1936; Concepcion Bay, 1, 1,625 mm., April 16, 1936; Clarion Island, 1, ca. 1,400 mm., May 11, 1936; Clarion Island, 1 (25,655), 3,886 mm., May 13, 1936; Tangola-Tangola Bay, 1 (26,051), 3,073 mm., Dec. 10, 1937; Costa Rica: Golfito, 1 (26,184), 3,200 mm., March 8, 1938; Panama: Pearl Islands, 1, 1,882 mm., June 27, 1933; Galápagos Islands: Tagus Cove, Albermarle Island, 1 (6159), 2,133 mm., June 7, 1925; Guy Fawkes Islands, 1, "18 or 20 feet," March 31, 1923, "seen to kill and devour a sea-lion pup"; Cocos Island: 1, "15 to 18 feet," May 17, 1925.

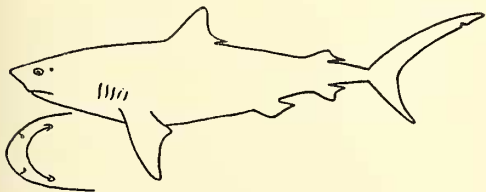
*References: Squalus arcticus*, Faber, F., *Fische Islands*, 1829: 17 (Iceland and neighboring seas).

*Galeocerdo tigrinus*, Jordan, D. S., & Gilbert, C. H., *Bull. U. S. Fish Comm.*, 2, 1882 (1883): 112 (San Jose de Guatemala). Gilbert, C. H., *Bull. U. S. Fish Comm.*, 2, 1882 (1883): 105 (Mazatlan, Mexico). Pellegrin, J., *Bull. Mus. Hist. Nat., Paris*, 7, 1901: 161, 166 (Gulf of California, danger to man). Snodgrass, R. E., & Heller, E., *Proc. Wash. Acad.*, 6, 1905: 342 (Albermarle and Narborough Islands, Galápagos

## *Galeocerdo* Müller & Henle, 1838.

### *Galeocerdo arcticus* (Faber).

Tiger Shark.



Text-figure 23.

*Range:* Tropical and temperate seas, north rarely to 70°. In the eastern coastal Pacific north to San Diego. (Mexico: Gulf of California, Santa Inez Bay, Concepcion Bay, Guaymas, Mazatlan, Tangola-Tangola; Guatemala: San Jose de Guatemala; Costa Rica: Golfito; Panama: Panama Bay and Pearl Islands; Clarion Island; Clipperton Island; Cocos Island; Galápagos Islands: Narborough, Albermarle and Guy Fawkes Island.)

*Field Characters:* A large, heavy shark with blunt head; caudal fin large with very long upper lobe, and well-developed lateral keels at base; teeth alike in both jaws, semicircular, with a



Islands). Fowler, H. W., *Proc. Acad. Nat. Sci. Phila.*, 60, 1908: 61 (jaws from Guaymas, Mexico). Beebe, W., "Galapagos: World's End," New York, 1924: 201, 434 (Guy Fawkes Islands, Galápagos; eating sea-lion pup).

*Galeocerdo maculatus*, Jordan, D. S., & Bollman, C. H., *Proc. U. S. Nat. Mus.*, 12, 1890: 179 (Panama).

*Galeocerdo arcticus*, Meek, S. E., & Hildebrand, S. F., *Marine Fishes of Panama*, 1, 1923: 56 (once taken on the Pacific Coast by the *Albatross*). Beebe, W., "The Arcturus Adventure," New York, 1926: 247, 435 (Cocos Island). Breder, C. M., Jr., *Bull. Bingham Oceano. Coll.*, 2 (1), 1928: 3 (specimen from unknown locality). Schmitt, W. L., *Annotated List of Fishes, Presidential Cruise, 1938*, privately printed, 1938: v (Weights; Cocos, Clipperton, and Galápagos Islands).

**Galeorhinus** Blainville, 1816.

We have no material referable to this genus. It is evident from the confused literature that careful study should be made of the relationships of the northern *Galeorhinus zyopterus* and of the specimens reported from Peru and Chile as *zyopterus*,<sup>19</sup> *galeus*,<sup>20</sup> *molinae*,<sup>21</sup> and *chilensis*.<sup>22</sup> Fowler<sup>23</sup> places all of these records under the name *galeus*.

Apparently there are no records of the genus from the tropical eastern Pacific, beyond those from Cedros Island and Peru, the northern and southern boundaries respectively, of our region.

Family SPHYRNIDAE.

**Sphyrna** Rafinesque, 1810.

Hammerhead and Shovelhead Sharks.

Key to tropical eastern Pacific species.<sup>24</sup>

- 1a. Second dorsal fin with a long posterior lobe, which when lifted upward, will reach about twice as high as the fin; anterior margin of the head three-lobed.....*zygaena*
- 1b. Second dorsal fin with a short posterior lobe, which when lifted upward, will reach about as high as the fin.
- 2a. Front margin of the head between the nasal apertures lobed, the front margin not forming a continuous curve.

<sup>19</sup> Evermann & Radcliffe, *U. S. Nat. Mus., Bull.* 95: 1917: 10.

<sup>20</sup> Fowler, *Proc. 4th Pac. Sci. Congr.* Java 1929, 3, 1930: 490.

<sup>21</sup> Philippi, *Ann. Univers. Chile*, 71, 1887: 543, Plate 4, fig. 2.

<sup>22</sup> Perez, *Estudios sobre algunos escualos de la costa de Chile*, 1886: 3.

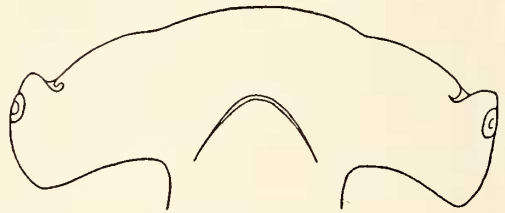
<sup>23</sup> Fowler, *l. c.*, 490.

<sup>24</sup> Adapted with slight modifications from Springer (1940). *Sphyrna peruana* Phillipi from Chile and Peru has not been considered here. The amount of material in our collection of *zygaena* and *tudes* is so small that we have made no attempt to determine whether the eastern Pacific species should be considered as local races, as seems to be indicated in many of the littoral tropical eastern Pacific sharks.

- 3a. Head hammer-shaped; oculo-narial expanse irregularly quadrangular, almost exactly transverse in old adults; teeth heavy, serrate.....*tudes*
- 3b. Head not definitely hammer-shaped; oculo-narial space irregularly oval; teeth slender, not serrate.....*corona*
- 2b. Front margin of the head between the nasal apertures not lobed, the front margin forming a continuous curve.
- 4a. Teeth with low cusps, the cusps progressively smaller towards the angles of the jaws, entirely absent on one or two rows in the upper jaw and on four or five rows in the lower jaw; head broadly spade-shaped; length of snout to mouth 1.5 to 1.75 in the internasal distance.....*vespertina*
- 4b. All teeth with cusps; oculo-narial space broadly oval; length of snout to mouth 2.2 in internasal distance.....*media*

**Sphyrna zygaena** (Linnaeus).

Cruz, Pez Martillo.



Text-figure 24.

*Range:* Tropical and temperate seas; known in the eastern tropical Pacific from southern California, Mexico, Panama, Peru and the Galápagos Islands. (Mexico: San Lucas Bay, Mazatlan, Guaymas; Panama: Panama; Peru: Lobos de Tierra, Callao; Galápagos Islands).

*Field Characters:* A large shark with head expanded laterally, hammer-shaped; anterior edge of head between nostrils three-lobed; a line connecting the centers of the eyes passes through the mouth; diameter of eye greater than anterior extension of head immediately in front of eye; posterior lobe of second dorsal fin, when lifted upward, reaches twice as high as the fin. (Illustration from specimen 25,549; 1,030 mm.)

*Size:* Grows to 17 to 20 feet and a weight of 1,500 pounds.

*Study Material:* 1 specimen. Mexico: San Lucas Bay, Lower California, 1 (25,549), 1,030 mm., May 5, 1936, harpooned.

*References:* *Squalus zygaena*, Linnaeus, *Syst. Nat.*, ed. X, 1758: 234 (original description; Europe, America).

*Sphyrna zygaena*, Jordan, D. S. & Gilbert, C. H., *Bull. U. S. Fish Comm.*, 2, 1882: 105 (Mazatlan). Jordan, D. S., & Gilbert, C. H., *Bull. U. S. Fish Comm.*, 2, 1882: 109 (Panama). Evermann, B. W., & Jenkins, O. P., *Proc. U. S. Nat. Mus.*, 14, 1891 (1892): 131 (2½ foot specimen from Guaymas, Mexico). Jordan, D. S., *Fishes of*

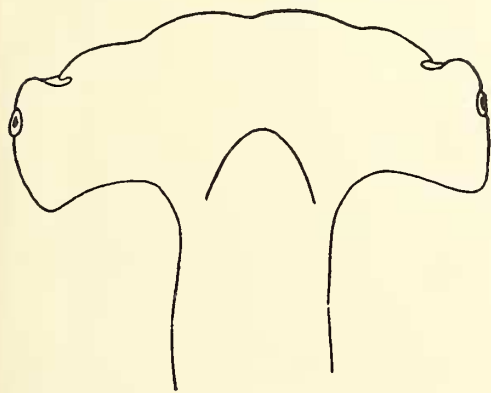


Sinaloa, 1895: 383 (Mazatlan). Jordan, D. S., & Evermann, B. W., *Fishes of North and Middle America*, 3, 1898: 2748 (Mazatlan). Pellegrin, J., *Bull. Mus. Hist. Nat., Paris*, 7, 1901: 161 (Gulf of California). Gilbert, C. H., & Starks, E. C., *Fishes of Panama Bay*, 1904: 13 (abundance in Panama Bay), 207 (range). Starks, E. C., *Proc. U. S. Nat. Mus.*, 30, 1906: 762 (eastern Pacific range), 763 (Callao, Peru). Garman, S., *Bull. Mus. Comp. Zool.*, 46 (12), 1906: 229 (Panama). Hussakof, L., *Copeia*, 34, 1916: 63-64 (comparison of Atlantic and Pacific hammerheads, development of teeth). Evermann, B. W., & Radcliffe, L., *Bull. U. S. Nat. Mus.*, 95, 1917: 5 (Lobos de Tierra, Peru; measurements of a 1,000 mm. shark, short synonymy, questioning relationship of *S. peruana* Philippi). Nichols, J. T., & Murphy, R. C., *Bull. Amer. Mus. Nat. Hist.*, 46, 1922: 504 (Lobos de Tierra, Peru). Walford, L. A., *Fish and Game of California*, *Bull.* 45, 1935: 40, fig. 38 (figure, notes). Walford, L. A., *California Fish and Game*, 17, 1931: 404 (off southern California coast, landed at San Pedro and Santa Monica). Clark, H. W., *Proc. Cal. Acad. Sci.*, (4) 21 (29) 1936: 395 (Galápagos Islands, pile of dried skins). Walford, L. A., *Marine Game Fish of the Pacific Coast*, 1937: plate 25 (figure). Seale, A., *Allan Hancock Pacific Expeditions*, 9 (1), 1940: 2 (Galápagos Islands; abundance).

*Cestracion zygaena*, Garman, S., *The Plagiostomia*, 1913: 157, plate 1, fig. 1-3 (Synonymy, des. of Atlantic specimen, figure).

*Discussion*: Our specimen from San Lucas Bay agrees well with illustrations of specimens recorded as *zygaena* from the Atlantic and other localities.

### *Sphyrna tudes* Valenciennes.



Text-figure 25.

*Range*: Tropical seas. (All of the definite records within the coastal tropical eastern Pacific area, are concentrated in the Gulf of California: Concepcion Bay, Arena Bank, San Francisquito Bay, Guaymas.)

*Field Characters*: A large shark with head

expanded laterally, hammer-shaped; anterior border of head between the nostrils four-lobed; a line joining the centers of the eyes passes in front of the mouth; diameter of eye equal to anterior extension of head immediately in front of eye; posterior lobe of second dorsal fin, when lifted upward, reaching about as high as the fin. (Illustration from specimen No. 25247; 1,334 mm.).

*Size and Weight*: Grows to about 5 feet.

*Study Material*: 2 specimens. Mexico: Concepcion Bay, Lower California, 1 (25,247), 1,334 mm., April 16, 1936 (head and pectoral fins preserved). Arena Bank, Lower California, 1 (25,485), May 1, 1936, dried head picked up on beach, 767 mm. across the "hammer."

*References*: *Sphyrna tudes*, Valenciennes, A., *Mem. Mus. Hist. Nat. Paris*, 9, 1822: 225, Pl. 12, fig. 1 (original description, figure). Evermann, B. W., & Jenkins, O. P., *Proc. U. S. Nat. Mus.*, 14, 1891 (1892): 131 (Guaymas; synonymy wrong). Pellegrin, J., *Bull. Mus. Hist. Nat. Paris*, 7, 1901: 161 (name only, Gulf of California), 166 (abundance). Breder, C. M., Jr., *Bull. Bingham Oceanogr. Coll.*, 2 (1) 1928: 4 (San Francisquito Bay, Gulf of California).

*Discussion*: The two fish at hand constitute too small a sample for adequate comparison with specimens of *tudes* from other localities. The large head agrees in shape and form with the head of the smaller example and there is no doubt that the two heads represent the same species. They both agree well with descriptions of *tudes* from other localities. The teeth of the large fish are lost; those of the 1,334 mm. shark are non-serrated.

This species, although supposedly wide spread in tropical seas, seems to be known in the eastern tropical Pacific only from the Gulf of California. Springer (1940) has shown that some of the older records within our faunal area that were assigned to *tudes* belong to new species described by him.

The Galápagos Islands record of *tudes*<sup>25</sup> of Snodgrass & Heller, is inconclusive and may refer to some of Springer's species.

### *Sphyrna corona* Springer.

*Range*: Panama (Panama City) and "west coast of Mexico."

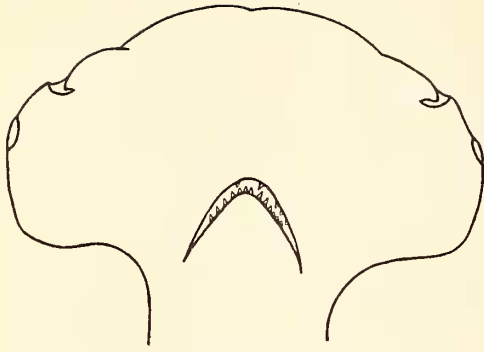
*Field Characters*: Medium sized sharks with head expanded laterally, kidney-shaped; front of head lobed, the posterior border of the head not parallel to the anterior border. (Illustration after Springer, 1940).

*Size*: Grows to about three feet.

*Study Material*: None.

*References*: *Sphyrna corona*, Springer, S., *Stanford Ichthy. Bull.*, 1 (5) 1940: 163, fig. 4 (original

<sup>25</sup> Snodgrass, R. E., & Heller, E., *Proc. Wash. Acad. Sci.*, 6, 1905: 345.



Text-figure 26.

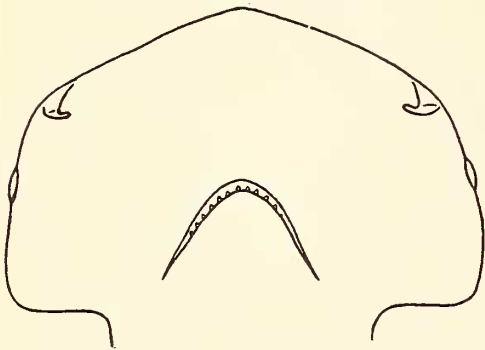
description, figure; type-locality Panama; type, No. 11,882, Stanford University).

*Sphyrna tudes*, Jordan, D. S., & Evermann, B. W., Fishes of North and Middle America, 1, 1896: 44 (in part).

*Sphyrna tiburo*, Kumada, T., & Hiyama, Y., Marine Fishes of the Pacific Coast of Mexico, 1937: 17, plate 1 (figure and short comment).

*Discussion*: Judging by head shape, the approximately 915 mm. shark figured by Kumada & Hiyama (*l. c.*) under the name of *Sphyrna tiburo*, is the same as *corona*.

#### *Sphyrna vespertina* Springer.



Text-figure 27.

*Range*: Panama and Ecuador.

*Field Characters*: A small shark with expanded spade-shaped head, the front margin of the head between the nostrils not lobed, the head slightly pointed anteriorly; teeth with low cusps, the cusps becoming progressively smaller toward the angles of the jaws, entirely absent on one or two rows in the upper jaw and on 4 to 5 rows in the lower jaw. (Illustration after Springer, 1940.)

*Size*: Grows to about three feet.

*Study Material*: None.

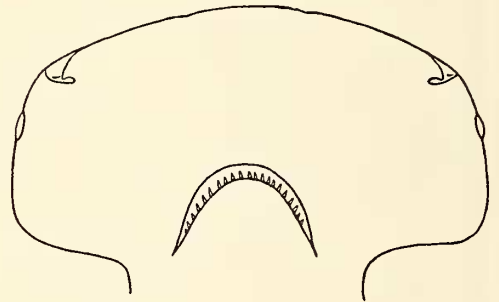
*References*: *Sphyrna vespertina*, Springer, S., *Stanford Ichthy. Bull.*, 1 (5), 1940: 161, fig. 2 (original description, figure; type-locality, Panama; type, No. 11,584, Stanford University).

*Sphyrna tiburo*, Gilbert, C. H., & Starks, E. C., Fishes of Panama Bay, 1904: 13 (Discussion of so-called *tiburo* and *tudes*). Wilson, C., *Ann. Carn. Mus. Pitts.*, 10, 1916: 58 (Guayaquil, Ecuador).

*Discussion*: Probably most of the eastern Pacific records of *tiburo* will be found to refer to this species. Springer in his 1940 paper infers that *tiburo* is Atlantic only, as he states of *vespertina* ". . . It is closely allied to *Sphyrna tiburo* of the Caribbean, Gulf of Mexico and the Atlantic coast of the Americas. . ."

The reference to *tiburo* of Kumada in "Marine Fishes of the Pacific Coast of Mexico," 1937: Plate 1, has been placed under *Sphyrna corona*. Specimens mentioned in the following references require study: Meek, S. E., & Hildebrand, S. F., Marine Fishes of Panama, 1, 1923: 60-61 (Panama); Starks, E. C., *Proc. U. S. Nat. Mus.*, 30, 1916: 762 (range), 763 (specimen from Guayaquil, Ecuador), and Jordan, D. S., Fishes of Sinaloa, 1895: 383 (one specimen from Mazatlan).

#### *Sphyrna media* Springer.



Text-figure 28.

*Range*: Mexico and Panama. (Mexico: Mazatlan; Panama: Panama market.)

*Field Characters*: Medium-sized sharks with head expanded laterally, the anterior margin between the nostrils in a continuous curve, not lobed; all teeth with cusps.

*Study Material*: None.

*References*: *Sphyrna media*, Springer, S., *Stanford Ichthyological Bull.*, 1 (5), 1940: 162, fig. 3 (original description, figure; type-locality, Mazatlan, Mexico; type, No. 11,583, Stanford University).

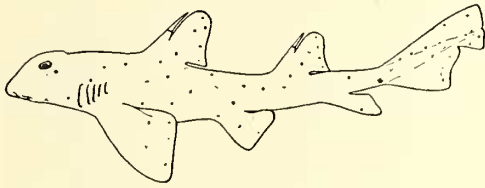
*Sphyrna tudes*, Jordan, D. S., Fishes of Sinaloa, 1895: 383 (Mazatlan, Mexico). Jordan, D. S., & Evermann, B. W., Fishes North and Middle America, 1, 1896: 44 (in part). Gilbert, C. H., & Starks, E. C., Fishes of Panama Bay, 1904: 13, (Panama market).

## Family HETERODONTIDAE.

*Heterodontus* Blainville, 1816.

Key to tropical eastern Pacific species.

- 1a. Origin of first dorsal fin over the base of the pectoral fins; distance from snout to origin of first dorsal 28 to 30% of the length; black spots on body separate and widely spaced, rarely merged together. . . . . *francisci*
- 1b. Origin of first dorsal fin behind the base of the pectoral fins; distance from snout to origin of first dorsal fin 32 to 37% of the length; black spots on body larger, three or four joining together to form larger spots or bands. . . . . *quoyi*

*Heterodontus francisci* (Girard).

Text-figure 29.

*Range:* Southern California, Lower California, Gulf of California. Recorded south of San Diego, California, from the following localities, Mexico: Todos Santos Bay, Magdalena Bay, Angel de la Guardia Island, Concepcion Bay and San Francisquito Bay.

*Field Characters:* Small robust sharks with eyes beneath heavy suborbital ridges and with a spine in front of each dorsal fin; spiracle present below posterior part of eye; origin of first dorsal fin over the base of the pectoral fin; upper surfaces of the body with black subcircular spots which are separate and detached from each other, rarely close together or merging. (Illustration after Kumada and Hiyama, 1937: 532 mm.)

*Size:* Grows to three feet.

*Study Materials:* No specimens were obtained by the Zoological Society's expeditions. We have examined fishes from Concepcion Bay, San Francisquito Bay and Angel de la Guardia Island, Gulf of California.

*References:* *Cestracion francisci*, Girard, C. F., *Proc. Acad. Nat. Sci. Phila.*, 7, 1854: 196 (original description; type locality: Monterey Bay, California).

*Heterodontus francisci*, Smith, R., *Proc. U. S. Nat. Mus.*, 6, 1883 (1884): 233 (Egg-cases on beach, Todos Santos Bay, Mexico). Pellegrin, J., *Bull. Mus. Hist. Nat. Paris*, 7, 1901: 161. (Gulf of California.)

*Gyropleurodus francisci*, Osburn, R. C., & Nichols, J. T., *Bull. Amer. Mus. Nat. Hist.*, 35, 1916: 141 (8' specimen dredged in 13 fathoms, Magdalena Bay, Mexico). Breder, C. M., Jr.,

*Bull. Bingham Oceanogr. Coll.*, 2 (1), 1928: 3 (Concepcion Bay and San Francisquito Bay, Gulf of California). Kumada, T., & Hiyama, Y., *Marine Fishes West Coast of Mexico*, 1937: 15, Plates 44, 45 (figure).

*Heterodontus quoyi* (Freminville).

*Range:* Peru (Lobos de Tierra and Lobos de Afuera Islands); Galápagos Islands. An indefinite record from the west coast of Mexico, and a possible egg-case of this species from San Elena Bay, Ecuador.

*Field Characters:* Small, robust sharks with eyes beneath heavy supraorbital ridges and with a short spine in front of each dorsal fin; spiracle present, beneath posterior part of eye; origin of first dorsal fin behind the vertical of the base of the pectoral. Brownish to grayish, the upper and lower surfaces of body with black spots which merge to form larger spots and bands. (Illustration from specimen No. 6161: 375 mm.)

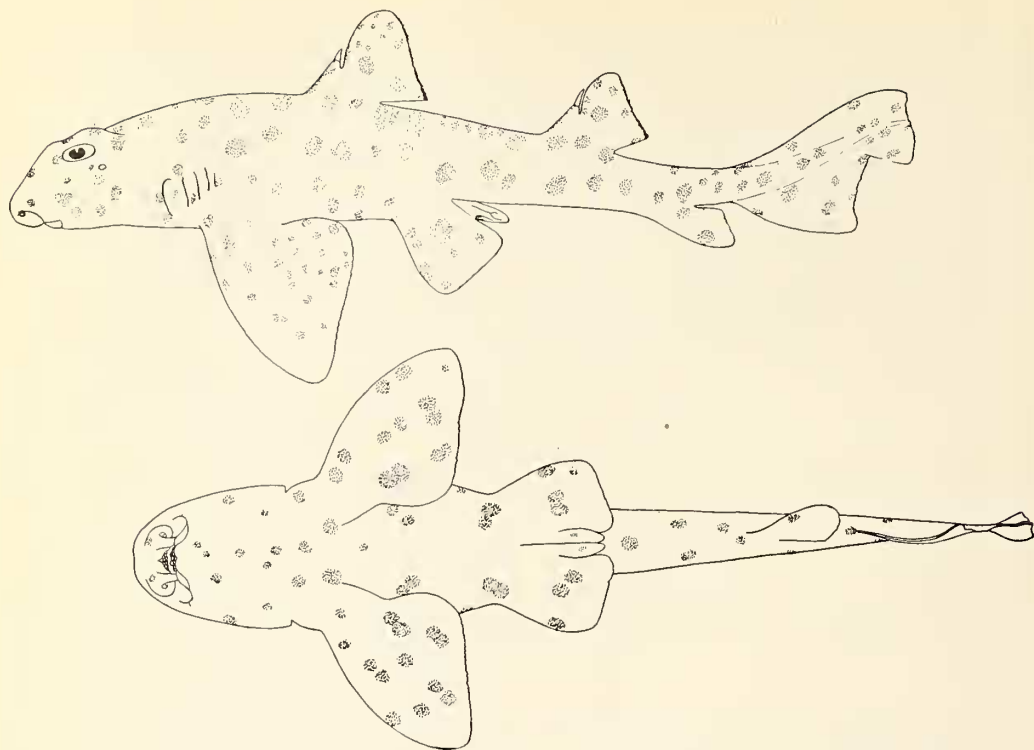
*Size:* Grows to at least eighteen inches.

*Description:* Our Galápagos Island specimen is described as follows, the proportions being expressed in percentages of the total length, which is 375 mm.:

Body robust, tapering posteriorly; snout to 1st gill-slit 18%, snout to fifth gill-slit 23.7; snout to eye 9.2, horizontal diameter of eye 3.3; a strong supra-orbital ridge ending less than an eye's diameter back of the eye, the ridges anterior to the eye converge at first and then become parallel and less evident on the snout. Snout to first dorsal fin 34, the fin originating about 2.6 back of the vertical of the posterior part of the pectoral base; base of first dorsal fin 8.25, anterior edge 13.6, base to tip of posterior lobe 5.1, vertical height of fin from body 10.4, the fin rounded above, its free edge slightly concave and with no posterior extension. Origin of first dorsal to tip of spine 6.7, vertical height of spine from body 5.85. Interdorsal space 17. Snout to second dorsal fin 54, the fin similar in shape but slightly smaller than the first dorsal fin. Caudal fin length 22, the fin with a large terminal lobe and a large inferior lobe, the length of the latter being 13.3. Snout to pectoral fin 19, the fin low, large and horizontal; pectoral base 8.8, anterior border 21.4, inner border 7.2, free border 16, greatest breadth 14.4. Snout to pelvic fin 42.7, the fin originating slightly posterior to the vertical of the posterior base of the first dorsal fin, pelvic fin base 7.85, anterior border 10.7, inner border 8.5; the claspers do not reach the inner tip of the fin. Snout to anal fin 68, the fin originating under the posterior tip of the second dorsal fin, the tip of the anal reaching to the base of the caudal, base of anal 5.5, anterior border 9.9, inner border 3.3. Height of first gill-slit 4, height of 5th gill-slit 2.27, the posterior three slits above the pectoral fin. Spiracle small, beneath and posterior to the eye.

Teeth similar to those mentioned in Garman's account (1913) and figure, except that the an-





Text-figure 30.

terior teeth have five rather dull cusps. The teeth in the Peruvian example that we have studied are much sharper and tricuspid, so that in this species as well as in *francisci*, there is an evident reduction with age in the number of cusps on the anterior teeth.

Denticles from the side immediately beneath the first dorsal fin are X-shaped with one of the arms of the X stronger and heavier toward its outer extremities. Denticles from the posterior part of the body have the spaces between the arms of the X filled in and the denticles are roughly rhomboidal in shape.

*Color:* Immediately after being taken from the stomach of a shark, above neutral gray, below and on sides dotted with large round black spots.

*Size and Weight:* Our 375 mm. fish weighed 456 grams (1 pound).

*Enemies:* The *Arcturus* specimen was taken from the stomach of a seven-foot tiger-shark (*Galeocerdo arcticus*).

*Egg Case:* See under *Discussion*.

*Study Materials:* 2 specimens. Galápagos Islands: Albemarle Is., 1, male (6161), 375 mm., June 9, 1925 (*Arcturus* Expedition), stomach of tiger-shark. Peru: Lobos de Afuera Island, 1 female (Amer. Mus. Nat. Hist. 7489) washed ashore dying.

*References:* *Cestracion quoyi*, Freminville, C. P., *Mag. de Zool.*, (2) 2, 1840: pl. 3 (description, figure; type-locality: Galápagos Islands). Gün-

ther, A., *Cat. Fishes Brit. Mus.*, 8, 1870: 416 (short description, synonymy).

*Cestracion pantherinus*, Valenciennes, A., Voyage "Venus," *Zoology*, 1845: 350, pl. 10, fig. 2 (description, excellent figure, Galápagos Islands).

*Tropidopus pantherinus*, Gill, T. N., *Proc. Acad. Nat. Sci. Phila.*, 1862: 489, 490 (new genus established for this species).

*Heterodontus (Cestracion) quoyi*, Dumeril, A. H. A., *Hist. Nat. Poiss.*, 1, 1865: 427; atlas, pl. 3, fig. 16, 17 (description, color, figure of teeth).

*Heterodontus quoyi*, Miklukho-Maklai, N. N., & Macleay, W., *Proc. Linn. Soc. N. S. Wales*, 3, 1878: 316, pl. 26, fig. 35 (comments, no specimens, copy of original plate of Freminville). Fowler, H. W., *Proc. 4th Pac. Sci. Congress*, Java 1929, 3, 1930: 484 (check-list only, Galápagos Islands).

*Gyropleurodus quoyi*, Jordan, D. S., & Evermann, B. W., *Fishes North and Middle America*, 1, 1896: 21 (poor description, synonymy), Regan, C. T., *Ann. Mag. Nat. Hist.* (8) 1: 494.

*Cestracion quoyi*, Garman, S., *The Plagiostomia*, 1913: 187, pl. 47, fig. 1-3 (description, synonymy, figure of teeth).

*Gyropleurodus peruanus*, Evermann, B. W., & Radcliffe, L., *Bull. U. S. Nat. Mus.*, 95, 1917: 2, pl. 1, fig. 1 (description, figure; type-locality: Lobos de Tierra Island, Peru). Nichols, J. T., & Murphy, R. C., *Bull. Amer. Mus. Nat. Hist.*, 46, 1922: 504 (Lobos de Afuera, Peru; specimen

washed ashore in dying condition). ? Kumada, T., & Hiyama, Y., Marine Fishes of the Pacific Coast of Mexico, 1937: 16, pl. 46 (west coast of Mexico; figure), see comment under *Discussion*.

*Heterodontus peruanus*, Fowler, H. W., *Proc. 4th Pac. Sci. Congr., Java* 1929, 1930: 484 (check-list; Peru).

*Discussion*: Two species of *Heterodontus* have been reported from the equatorial eastern Pacific, *quoyi* from the Galápagos Islands and *peruanus* from the coast of Peru.

The original description of *quoyi* (Freminville, 1840) is very poor and the figure that illustrates the description is crude. The plate shows a fish with an exceedingly small pectoral fin, an anal fin with its origin beneath the tip of the posterior extension of the second dorsal fin and with very large, irregularly-formed dark spots.

Valenciennes, in 1855, redescribed the Galápagos fish under the name *Cestracion pantherinum*, giving an excellent figure with details of anatomy and color that agree well with our recent Galápagos material.

Garman (1913) described an 18-inch female of *quoyi* from the Galápagos Islands and gave splendid figures of the teeth. Unfortunately, we have been unable to find the specimen or specimens upon which his description was based.

Evermann & Radcliffe first described and figured the South American coastal form, *peruanus*, the type being a 565 mm. fish from Lobos de Tierra, Peru.

For purposes of comparing *quoyi* and *peruanus*, we have, in addition to the descriptions mentioned above, two topotypical specimens, a 375 mm. fish from Tagus Cove, Albemarle Island, Galápagos Islands, and a 523 mm. fish (Amer. Mus. Nat. Hist. 7489) previously recorded by Nichols & Murphy from Lobos de Afuera, Peru, some 20 miles from the type locality of *peruanus*. The latter specimen agrees completely with the original description and figure of *peruanus*.

As these fish are of different sizes, there is a slight question as to their identity. Consequently it is necessary to take up the discussion in some detail, although there is no doubt in our minds that they belong to the same species.

When Evermann & Radcliffe described *peruanus*, they stated: "This species appears to be most closely related to the poorly described *quoyi*, but differs in coloration, in insertion of the anal and relative size of the pectoral."

However, when the two specimens at hand, representing topotypical examples of both *quoyi* and *peruanus*, are compared, we find that the relative sizes of the pectoral fins are exactly the same (the proportional measurements are identical), and that the insertion of the anal fin is in the same relative position in the two fishes. This leaves only the color as supposedly different.

As our Galápagos Island shark is smaller than the two known Peruvian fishes and as it was taken from the stomach of a tiger-shark, its color cannot be depended upon for direct com-

parisons. The general pattern, where observable, consists of large diffuse dark spots similar to those of the Peruvian shark, and in this, it agrees with Valenciennes' figure of a Galápagos fish illustrated in the "Voyage of the Venus."

In the original description of the Peruvian form, conspicuous black bands on the dorsal surface are recorded. In Garman's description of a similar sized Galápagos specimen the same pattern is mentioned. However, in the American Museum Peruvian fish, in our Galápagos Island specimen and in Valenciennes' plate there is no indication of these bands. Evidently their presence or absence is variable. Under any circumstances, it is obvious that the difference in pattern cannot be assigned to a geographical range.

Thus we find that the coloration and pattern in the two nominal forms are the same, and as there are thus no distinguishing characters left between the coastal and the South American mainland form, we consider them as identical.

All of the known Galápagos and Peruvian specimens of *Heterodontus* have relatively low and robust dorsal spines. The northern species, *francisci*, has much longer and slimmer spines. This distinction is most marked in smaller specimens, but it also holds true when comparisons are made with equal-sized larger specimens.

The specimen illustrated by Kumada & Hiyama (Marine Fishes of the Pacific Coast of Mexico, 1937: 16, Plate 46) introduces an uncertain note into the discussion of the American species of *Heterodontus*. This fish was found far north of the range of *quoyi* as previously recorded and within or near the range of *francisci*. Kumada & Hiyama's plate, which was based upon a photograph, shows a fish with the dorsal fin insertion like that of *francisci*, while the shape and size of the dorsal fins is that of *quoyi*. The color pattern is intermediate between the two forms, the spots being larger than in *francisci* and more isolated and separated than is the case in *quoyi*. The general appearance, however, is predominantly *quoyi*-like. For the present, we assume that this fish was correctly assigned to *peruanus*, and that the differences are merely variations from our present conception of the species. The exact locality from which the Kumada & Hiyama shark was taken is unknown—somewhere along the west coast of Mexico.

An egg-case of a heterodontid shark dredged by us at Station 136:D-16, Arena Bank, Gulf of California, April 20, 1936, in 45 fathoms, amply validates the existence of a second species of bull-head shark in the northern part of the tropical eastern Pacific in addition to *francisci*. This egg-case probably belongs to the present species as exemplified by Kumada & Hiyama's specimen.

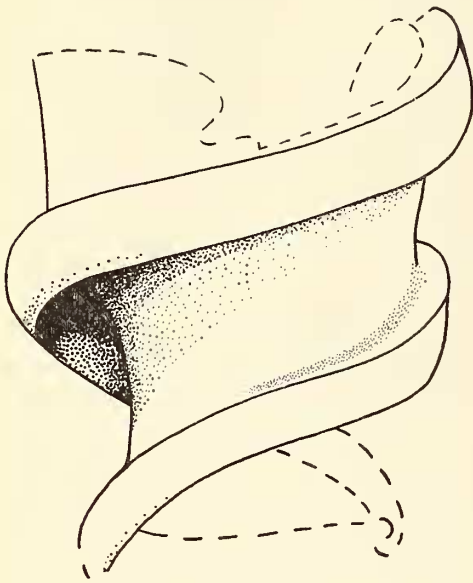
The egg-case of *Heterodontus francisci* is well known, and has been figured by Daniels<sup>26</sup> and Barnhart;<sup>27</sup> it is screw-shaped with characteristic

<sup>26</sup> Daniels, J. F., *The Elasmobranch Fishes*, 1922: 318.

<sup>27</sup> Barnhart, P. S., *Bull. Scripps Inst. Oceanogr. Tech. ser.*, 3 (4) 1932: 88.



flanges and lacks tentacles. Our specimen is quite different and resembles in general form and the possession of long tentacles, the egg-case of *Heterodontus galeatus* as illustrated by Waite.<sup>28</sup>



Text-figure 31.

When first secured our egg-case was broken at the top (considering the smaller tentacled end as the bottom, as shown in Waite's figure<sup>28</sup> and since then it has become even more fractured and fragmentary. However, even from this material it is evident that this egg-case can be distinguished from that of *galeatus* by the fact that the spiral flanges have their outer border vertical; i. e., more or less parallel to the long axis of the egg-case and that the upper aspect of the flange is a flat ledge at a right angle with the body of the egg-case. In Waite's illustration of the *galeatus* egg-case, these flanges are oblique to the vertical axis, more or less continuing the general direction of the body of the egg-case.

The width across the widest portion of the egg-case is approximately 44 mm., the width of one of the flanges at about the middle of the egg-case is 7.5 mm.

Tortonese<sup>29</sup> reports a somewhat similar egg from Ecuador under the name of *Heterodontus* sp., although we do not understand his reference to four appendages. This must certainly belong to *quoyi*; it was 64 mm. long.

<sup>28</sup> Waite, E., *Journ. Linn. Soc. Zool. Lond.*, 25, 1896: Plate 12, and "The Fishes of Australia," Part 1, Sharks, etc., 1940: 38.

<sup>29</sup> Tortonese, E., *Boll. Musei Zool. Anat. Comp. Torino*, (3) 47, no. 89, 1939: 2.

## Family SQUALIDAE.

*Centroscyllium* Müller & Henle, 1838.*Centroscyllium nigrum* Garman.

Text-figure 32.

*Range:* Offshore Panamic region in 546 to 625 fathoms; taken 15 miles west of Mariato Point, Panama, 65 miles south-west of Mariato Point, Panama, and 60 miles south of Cocos Island, Offshore, Kauai Island, Hawaiian Islands in 385 to 500 fathoms.

*Field Characters:* Very small, large-eyed sharks with well-developed spiracle and with a spine before each dorsal fin; anal fin lacking. Black with white outer borders to the dorsal, pectoral and ventral fins. (Illustration from specimen No. 6013; 278 mm.)

*Color:* Black with white dorsal spines and posterior borders to the dorsals, pectorals and pelvic fins; eye emerald green.

*Size:* Grows to about a foot in length.

*Food:* Our specimens had fed upon scarlet prawns.

*Study Material:* 8 specimens. Station 74:OT-4, *Arcturus* Oceanographic Expedition, 4° 50' N., 87° 00' W., 60 miles south of Cocos Island, 625 fathoms (1,145 meters), 125 to 278 mm. long, May 30, 1925, otter trawl. Cat. Nos. 6013, 6014a, b, c, d, e, f, g.

*References:* *Centroscyllium nigrum*, Garman, S., *Mem. Mus. Comp. Zool.*, 24, 1899: 28, Plate 1, fig. 2, Plates 4 and 5, Plate 69, fig. 1 (original description, skull and skeletal characters, heart, skin, sensory system, color; figure, figures of head, skull, teeth, denticles, branchial cartilages, intestine, shoulder and pelvic girdles and lateral line systems; type locality: Pacific Ocean, between 6° and 7° N. Lat., and 81° and 82° W. Long., in depths of 546 to 555 fathoms). Garman, S., *The Plagiostomia*, 1913: 231 (synonymy, description). Beebe, W., "The *Arcturus* Adventure," G. P. Putnam's Sons, New York, 1926: 359 and 436 (color and food).

*Centroscyllium ruscusum*, Gilbert, C. H., *Bull. U. S. Fish Comm.*, 23, 1905: 580, fig. 230 (description, figure, color).

*Discussion:* Garman<sup>30</sup> states of this species: "One of the more prominent differential characters of the species described below, *C. nigrum*, is apparent in the five cusped teeth, the teeth of each of the other species being described as tricuspid. . . ." However, the specimens at

<sup>30</sup> Garman, *Mem. Mus. Comp. Zool.*, 24, 1899: 27.

hand from close to the type-locality and from the same depths as the type of *C. nigrum*, demonstrate considerable variation from this description. Thus the lower jaw teeth possess, for the most part, but three cusps with indications of a single additional cusp on each side, making five in all as in the original description of the species. However, these additional cusps are very small and never as prominent as shown in the original figures of the species. Without careful observation they might easily be missed. They can most easily be seen when the teeth are dried and viewed with transmitted light.

In the description of the cotype of the nominal *ruscosum*, Gilbert found the same condition.

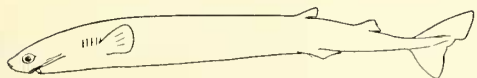
### *Squalus* Linnaeus, 1758.

Gunther's questionable Panama record of *Acanthias vulgaris*<sup>31</sup> cannot be referred to any definite known species, and it also may have come from the Atlantic. Comments on this record have been made by Gilbert & Starks,<sup>32</sup> and Meek & Hildebrand.<sup>33</sup> Beyond this note the genus is unrecorded from the eastern tropical Pacific, although *Squalus suckleyi* is known from immediately north of the region and is also reported from Chile, while *Squalus lebruni* and *S. fernandinus* are known from south of the region.

### Family SCYMNORHINIDAE.

#### *Isistius* Gill, 1864.

##### *Isistius brasiliensis* (Quoy & Gaimard).



Text-figure 33.

**Range:** Known from many localities in tropical and temperate seas; in the eastern tropical Pacific known from Hawaii and in our region from a single specimen taken in open ocean 150 miles north of the Galápagos Islands. Taken principally near the surface, doubtfully recorded from great depths.

**Field Characters:** Small, large-eyed sharks with very small dorsal fins placed far back on the body, no anal fin, a dermal keel on each side of the tail, a short deep caudal fin. Brown, with a darker band around the neck across the gill-openings; lower surfaces lighter to white. (Illustration after Garman, 1899; 460 mm.)

<sup>31</sup> Gunther, A., *Trans. Zool. Soc. London*, 7, 1868: 396.

<sup>32</sup> Gilbert, C. H., & Starks, E. C., *Fishes of Panama Bay*, 1904: 13.

<sup>33</sup> Meek, S. E., & Hildebrand, S. F., *Marine Fishes of Panama*, 1, 1923: 64.

**Size:** Grows to 19½ inches in length.

**Study Material:** None.

**References:** *Scymnus brasiliensis*, Quoy, J. R. C., & Gaimard, P., in Freycinet, L. de, *Voyage autour du monde pendant 1817-1820, 1824*: 198 (type locality: off Brazil).

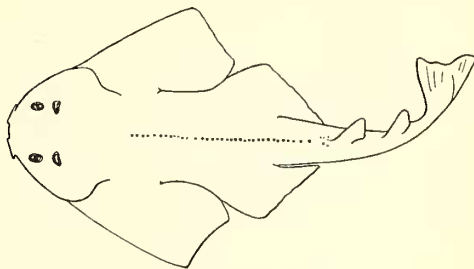
*Isistius brasiliensis*, Garman, S., *Mem. Mus. Comp. Zool.*, 24, 1899: 34, Plate 1, fig. 1, Plate 2 and 3, Plate 49, fig. 2 (synonymy, description, skull, skeleton, internal organs, lateral line system, coloration, phosphorescence, historical notes; 1 specimen 18 inches long, taken 153 miles N by W of Albemarle Island, Galápagos Islands, in beam trawl).

### Family SQUATINIDAE.

#### *Squatina* Dumeril, 1806.

##### *Squatina californica* Ayres.

Angel Shark.



Text-figure 34.

**Range:** South-eastern Alaska to San Diego with two indefinite records from Mexico, and questioned records from Peru and Chile.

**Field Characters:** A flattened ray-like shark with gill openings on the sides in a space between the head and the expanded pectoral fins; ventral fins expanded. Dark brownish or ashy, almost black, or reddish-brown above; white below.

**Size:** Attains a length of five feet and a weight of 60 pounds.

**Study Material:** None.

**References:** *Squatina californica*, Ayres, W. O., *Proc. Cal. Acad. Sci.*, 1859; 29; *ibid.*, 1860: fig. 7 (original description, outline figures; type locality, San Francisco). Garman, S., *The Plagiostomia*, 1913: 253, plate 16, figs. 1-4, plate 61, figs. 9-11 (description, figures; range: California and Mexico). Kumada, T., & Hiyama, Y., *Marine Fishes of the Pacific Coast of Mexico*, 1937: 17, plate 49 (plate and brief diagnosis of a specimen from somewhere along the west coast of Mexico).

*Squatina squatina*, ? Evermann, B. W., & Radcliffe, L., *U. S. Nat. Mus., Bull.* 95, 1917: 11 (dimensions, short description, color; Lobos de Tierra, Peru). ? Pellegrin, J., *Bull. Soc. Zool. Paris*, 29, 1904 (Chile).



*Discussion:* The status of specimens of the genus *Squalina* from localities in the eastern Pacific is by no means clear. Thus there exists a tendency to amalgamate the European, the western Atlantic and eastern Pacific angel-sharks under the all-inclusive name *Squalina squalina* (Linnaeus). In keeping with this, *S. californicus* Ayres, described from California, has been synonymized with *S. squalina*, and specimens from Peru and Chile have also been reported under the same name.

Whether the angel-sharks from northern and southern localities in the eastern Pacific represent the same species and whether they should be considered as the same as the European *squalina*, is a question. Our assumption, based on observations of other littoral sharks of the region, is that the eastern fish are not the same as the Atlantic or European form, and that a northern and southern species of the eastern Pacific fish could probably be differentiated. Thus we are uncertain as to the status of the 560 mm. fish recorded from Lobos de Tierra by Evermann & Radcliffe<sup>34</sup> and the fish recorded by Pellegrin from Chile.<sup>35</sup> Norman<sup>36</sup> suggests that the former record may refer to *S. armata* (Philippi).

Two additional species of *Squalina* have been recorded from the west coast of South America: *S. armata* Philippi<sup>37</sup> described from Iquique, Chile, and redescribed by Norman<sup>38</sup> from an Argentine specimen with a question as to its identity, and *S. philippi* Garman<sup>39</sup> from Mxilones, Chile.

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<sup>34</sup> Evermann, B. W., & Radcliffe, L., *U. S. Nat. Mus.*, *Bull.* 95, 1917: 11.

<sup>35</sup> Pellegrin, J., *Bull. Soc. Zool. Paris*, 29, 1904:

<sup>36</sup> Norman, J. R., *Discovery Reports*, 16, 1937: 10, 11.

<sup>37</sup> Philippi, R. A., *Ann. Univ. Chile*, 71, 1887: 561, pl.

7, fig. 1.

<sup>38</sup> Norman, J. R., *Discovery Reports*, 15, 1937: 10.

<sup>39</sup> Garman, S., *The Plagiostomia*, 1913: 254.

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#### PLATE I.

- Fig. 1. *Rhineodon typus*. 42-foot specimen from Arena Bank, Lower California.
- Fig. 2. *Rhineodon typus*. Whale shark photographed from motor boat while swimming close to surface, Gorda Banks, Lower California. View of part of head, body, gill-slits and pectoral fin. Two remoras are on the base of the pectoral fin.

#### PLATE II.

- Fig. 1. *Triacnodon obesus*. Specimen from Bahia Honda, Panama, 1,175 mm. total length.
- Fig. 2. *Eulamia aethalorus*. Embryo, 650 mm., taken from 2,070 mm. adult, Arena Bank, Lower California.
- Fig. 3. *Eulamia velox*. Specimen from San Lucas Bay, Lower California, 945 mm. total length.